INSTRUCTION MANUAL

Serial Number _ _____

TYPE 3A3

DUAL-TRACE DIFFERENTIAL AMP

Tektronix, Inc.
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A list of abbreviations and symbols used in this manual will be found on page 6-1. Change information, if any, is located at the rear of the manual.

Type 3A3 Dual-Trace Differential Amplifier.

SECTION 1
CHARACTERISTICS

Introduction

The Type 3A3 Dual-Trace Differential Amplifier is designed for use with all Tektronix 560-Series Oscilloscopes except the Type 560 itself. The Type 3A3 contains two independent, high-gain amplifier channels. Either channel may be used to produce a display, or the two channels may be electronically switched to produce dual-trace displays.

The Type 3A3 has high sensitivity with direct-coupled inputs and a high degree of common-mode rejection.

Sensitivity

Sixteen calibrated deflection sensitivities in a 1-2-5 sequence from 0.1 mvolt to 10 volts per major graticule division. The front-panel VARIABLE control provides a continuously variable uncalibrated sensitivity range from 0.1 mvolt to at least 25 volts per major graticule division.

Accuracy

Calibrated sensitivities are accurate within 3%. Any selected sensitivity of either channel is adjustable to 0% with the front-panel CALIBRATE control.

High-Frequency Response

500 kc minimum (—3 db) with BANDWIDTH switch set to HI.

5 kc minimum (—3 db) with BANDWIDTH switch set to LO.

Low-Frequency Response

Dc-Coupled Input—Dc at all sensitivities when the AC STAB switch is set to OFF. When the AC STAB switch is set to AC STAB, the low-frequency response at the four highest sensitivities changes as follows:

1 mVOLTS	≈0.15 cps (—3 db)
.5 mVOLTS	≈0.3 cps (—3 db)
.2 mVOLTS	≈0.75 cps (—3 db)
.1 mVOLTS	≈1.5 cps (—3 db)

Ac-Coupled Input[2]—About 1.6 cps (—3 db) at all sensitivities when the AC STAB switch is set to OFF. When the AC STAB switch is set to AC STAB, the low-frequency response at the two highest sensitivites changes as follows:

.2 mVOLTS	≈1.75 cps (—3 db)
.1 mVOLTS	≈2.2 cps (—3 db)

Common-Mode Rejection[3]

	.1 mVOLTS to 10 mVOLTS[4]			
	Referred to Input Connectors		Referred to Input of Properly Adjusted P6023 Probes	
	Dc-Coupled Input	Ac-Coupled Input With Low-Z Source	Dc-Coupled Input	Ac-Coupled Input With Low-Z Source
Dc to 100 kc	50,000:1			
500 kc	1,000:1	1,000:1		
Dc to 10 cps			50,000:1	
15 cps		500:1		
60 cps		2,000:1		
100 cps			10,000:1	
1 kc to 10 kc			1,000:1	1,000:1
100 kc		50,000:1	500:1	500:1

20 mVOLTS to 10 VOLTS[5]				
Dc to 1 kc	10,000:1			
Dc to 100 kc	1,000:1			
500 kc	500:1	500:1		
15 cps		500:1		
60 cps		2,000:1		

[1]When the 10 mvolt/div sensitivity has been calibrated for the crt deflection sensitivity of a particular oscilloscope. See Section 2, "First-Time Operation".

[2]When no attenuator probe is used and the signal-source impedance is negligible compared to 1 megohm.

[3]For ground-referenced sine-wave common-mode signals.

[4]With 10 volts peak-to-peak or less in common mode at input connectors.

[5]With common-mode amplitude at input connectors of 100 volts peak-to-peak or less for 20 mVOLTS to .1 VOLTS, and with 600 volts peak-to-peak or less for .2 VOLTS to 10 VOLTS.

Maximum Common-Mode Amplitudes

600 volts peak (input breakdown rating) from 10 VOLTS to .2 VOLTS.

200 volts peak from .1 VOLTS to 20 mVOLTS.

20 volts peak at 10 mVOLTS, increasing to 25 volts peak at .1 mVOLTS.

Noise[6]

40 μvolts peak-to-peak or less with the BANDWIDTH switch set to HI.

10 μvolts peak-to-peak or less with the BANDWIDTH switch set to LO.

Interchannel Isolation

Electrostatic isolation is 10^6:1 (120 db) or better referred to input signal levels.

Switching isolation in chopped operation is 100:1 or better referred to centimeters of display. The switching circuit introduces negligible interaction in all other operating modes.

Drift[6]

Typically less than 500 μvolts/hour after 30-minute warm-up.

Input Parameters

Input Coupling—Switch provides ac or dc coupling, or grounds the amplifier input without grounding the signal source. The ground position of the switch permits precharging the ac-coupling capacitor. See Section 2.

Input Resistance and Parallel Capacitance—1 megohm ±1% paralleled by 47 pf ±3%. The 1 meghom input resistance can be eliminated to provide floating inputs when any of the seven most sensitive ranges are used for dc-coupled signals. Removeable wire links are provided for this purpose on the attenuator etched wiring boards. See Section 2.

Grid Current—Typically less than 1 nanoampere. An internal calibration control diverts the grid current away from the input connector (except when the floating input provision is used). The range of this control is adequate to divert up to 12 nanomperes.

Ac-Coupling Time Constant—≈0.1 sec when the signal source impedance is negligible compared to 1 megohm. ≈1 sec with a X10 probe.

Coupling Capacitor Leakage—Typically less 1 nanoampere at 500 volts after 1 minute.

Nondestructive Differential Voltage Limits—±600 volts from 10 VOLTS to 20 mVOLTS, dc coupled. ±200 volts from 10 mVOLTS to .1 mVOLTS, dc coupled.

Operating Modes

Channel 1 only, Channel 2 only, or dual trace with either chopped or alternate switching.

Chopped mode provides alternating samples of the two channels which are of about 2 μsec duration. The Type 3A3 provides a signal to the oscilloscope crt circuit for display blanking during the switching interval.

Alternate mode displays the two channels alternately, each for the duration of one time-base sweep.

X-Y Displays

Two Type 3A3 plug-in units used for X-Y displays exhibit a phase-shift difference of less than 2° up to 100 kc.

Dual-trace X-Y displays can be obtained with two Type 3A3 plug-in units or one Type 3A3 and a Type 3A74. See Section 2.

Output Cathode Followers

Cathode followers provide a ground-referenced differential signal output at pins 11 and 12 of the interconnecting plug. The output signal can be selected from Channel 1, Channel 2, or the common output amplifier (see Section 2). The signal is available as the internal triggering signal to the companion time-base unit. Jacks can be installed in the oscilloscope for access to these outputs.

Bandwidth—Dc to at least 350 kc.

Amplitude—2.5-volt differentially per major graticule division of display with TRIGGER switch at CH 1 or CH 2.

5-volt differentially per major graticule division of display with TRIGGER switch at COMP.

Output Resistance—≈500 Ω per side.

Minimum Load Resistance—100 k.

Mechanical

Construction—The chassis is aluminum alloy and the front panel is photo-etched anodized aluminum.

Dimensions (approx.)—6¼ inches high, 4¼ inches wide, 14⅜ inches deep (overall).

Weight—About 5⅝ pounds net.

Accessories Included

	Tektronix Part Number
4—BNC to binding-post adapters	103-033
2—Instruction Manuals	070-408

[6]Measured on the crt display with respect to the selected deflection sensitivity and with the input grounded.

SECTION 2

OPERATING INSTRUCTIONS

FUNCTION OF CONTROLS

VOLTS/DIV — Volts per major graticule division. Sixteen-position switch used to select the calibrated deflection factors.

VARIABLE — Variable volts per division. Provides continously variable attenuation between the calibrated deflection factors and extends the attenuation range to at least 25 volts/div. This control has 360° rotation with a detent position for CALIB (calibrated) operation.

POSITION — Provides display positioning

RANGE — Attenuator balance range. Forty-turn screwdriver adjustment used in conjunction with the ATTEN BAL control to dc balance the Input Amplifier. Proper adjustment of the two complimentary controls is indicated when the VOLTS/DIV control can be switched throughout its range without moving the trace.

ATTEN BAL — Attenuator balance. See RANGE control description and "First-Time Operation" in this section.

AC STAB — Ac stabilization. Obtainable only when one of the four most sensitive positions of the VOLTS/DIV switch (marked in blue) is used. The AC STAB position causes attenuation of drift and other low-frequency information, resulting in a more stable display of ac information.

AC GND DC — Ac-coupled input, ground input, or dc-coupled input. AC position places a dc-blocking capacitor in the circuit. GND position grounds the input of the internal attenuator without grounding the input connector. When dc levels are to be blocked by ac coupling, the switch should be set to GND while input connections are made or broken. This will permit the coupling capacitor charge to change without damaging the input circuitry or overdriving the amplifier (see Section 3). The DC position provides a straight-through connection to the attenuator.

BANDWIDTH — Simultaneously controls upper frequency-response limit of both channels. The HI position provides —3 db at about 500 kc; LO position provides —3 db at about 5 kc. The LO position permits attenuation of high-frequency noise while low-frequency measurements are being made.

MODE — Four-position switch which permits selection of Channel 1 only, Channel 2 only, Channel 1 and Channel 2 alternating with each successive time base sweep, or Channel 1 and Channel 2 chopped at a rate which provides display segments of about 2 μsec per channel.

TRIGGER — Three-position switch to permit selection of the internal triggering signal information from Channel 1 only, Channel 2 only or the channel being displayed (COMP). When the TRIGGER switch is set to COMP, the triggering-signal information will be the same as the display information selected by the setting of the MODE switch.

CALIBRATE — Screwdriver adjustment which permits the operator to calibrate the input deflection sensitivity. This control is the output amplifier gain control and therefore affects both channels equally. See "First-Time Operation".

FIRST-TIME OPERATION

The following procedure is intended to acquaint the operator with the operational adjustments and basic functions of the Type 3A3.

1. Install the Type 3A3 in an oscilloscope and allow at least a 10-minute warmup.
2. Set the controls as follows:

Channel 1 and Channel 2	
VOLTS/DIV	10 mVOLTS
VARIABLE	Slightly clockwise from the detent position.
POSITION	Midrange
ATTEN BAL	Midrange
AC STAB	OFF
AC GND DC, (+) and (—)	GND
Common Controls	
MODE	CH 1
TRIGGER	COMP
BANDWIDTH	LO

3. Set the companion time-base controls to display a free-running sweep at 0.5 msec/div.
4. Use the Channel 1 POSITION control to move the trace to the graticule centerline.
5. Turn the Channel 1 VARIABLE control clockwise and re-center the trace by adjusting the RANGE control. The time lag between adjustment and trace movement is normal.

6. Continue this adjustment until the trace is near the graticule centerline with the VARIABLE control in the detent (CALIB) position and the POSITION control set at midrange.

7. Use the POSITION control to center the trace. Then set the VOLTS/DIV switch to 5 mVOLTS and adjust the RANGE control to recenter the trace.

8. Using the 10 mVOLTS position to determine the reference trace position, refine the adjustment of the RANGE control for minimum trace movement as the VOLTS/DIV switch setting is changed from 10m VOLTS to 1 mVOLTS.

9. When the trace position has stabilized with the VOLTS/DIV switch set to 1 mVOLTS, again determine the reference trace position with the VOLTS/DIV switch set to 10 mVOLTS.

10. Set the VOLTS/DIV switch to .1 mVOLTS and recenter the trace using the ATTEN BAL control. If the adjustment of the RANGE control was adequately refined, the ATTEN BAL control should now be within about 45° of midrange.

11. Set the MODE switch to CH 2 and repeat these adjustments.

12. The next several steps pertain to the operational adjustment of the internal GAIN controls and the front-panel CALIBRATE control. These controls were set at the factory with the Type 3A3 installed in the vertical-axis compartment of a Tektronix Type 561A Oscilloscope. The crt vertical and horizontal deflection sensitivites always differ in any 560-Series oscilloscope. Moreover, the deflection sensitivities of the same axis in any two 560-Series oscilloscopes may also differ. Because of these differences, the input deflection sensitivity of the Type 3A3 should always be checked when it is first installed in an oscilloscope or moved from one compartment to the other in the same oscilloscope.

13. Set the MODE switch to CH 1 and the Channel 1 VOLTS/DIV switch to 10 mVOLTS. Apply a 50-mvolt peak-to-peak signal to the Channel 1 (+) input connector from an oscilloscope amplitude calibrator. (The following adjustments will be only as accurate as the voltage accuracy of the amplitude calibrator.) Set the Channel 1 (+) AC GND DC switch to DC.

14. Set the POSITION control to obtain two traces separated by several major graticule divisions. If adequate range is available, set the CALIBRATE control for exactly 5 major graticule divisions separation between the traces. Do not include the thickness of the trace in the measurement. If inadequate range is available or if the control is set near either extreme, perform steps 15 and 16. Otherwise, proceed to step 17.

15. The Type 3A3 should be in the left-hand compartment of the oscilloscope for this and the next step. (An exception to this is discussed in step 27 of the Calibration Procedure in Section 5 of this manual.) Reset the CALIBRATE control to midrange. Set the internal Channel 1 GAIN control (R175) for exactly 5 major graticule divisions separation between the two traces. Set the Channel 1 (+) AC GND DC switch to GND, the MODE switch to CH 2, the Channel 2 (+) AC GND DC switch to DC, and the Channel 2 VOLTS/DIV switch to 10 mVOLTS.

16. Move the signal connection to Channel 2 and adjust the Channel 2 internal GAIN control (R375) for exactly 5 major graticule divisions separation between the two traces.

17. Step 16 completes the operational adjustments. If you now choose to move the Type 3A3 to the other compartment of the oscilloscope, reset the CALIBRATE control as described in step 14. The following steps are a self-demonstration procedure intended to illustrate some basic concepts pertaining to dual-trace operation of the Type 3A3.

18. Set all four AC GND DC switches to GND and the MODE switch to ALTER. There should now be two traces on the crt; one controlled by the Channel 1 POSITION control and the other by the Channel 2 POSITION control. Position one trace about 2 major divisions above the graticule centerline and the other about 2 major divisions below. Set the time-base sweep rates to 50 msec/div. Although the previous sweep rate appeared to present a simultaneous display of the two traces, the slower sweep rate should now make it apparent that the traces are presented alternately (ALTER). This can be a disadvantage when using Alternate mode with slow sweep rates.

19. Set the MODE switch to CHOP. Note that the traces now appear to be simultaneous. (If your oscilloscope has a rear-panel CATHODE SELECTOR switch, set it to the CHOPPED BLANKING position.) Set the time-base sweep rate to 2 μsec/div and the trigger controls for a triggered display. You should now note that each trace is made up of segments about 2 μsec long. The segmented appearance will rarely be as obvious as it is now since the display will not normally be triggered in this manner. However, when one-shot signals or signals which are harmonically related to the trace-switching rate are involved, the segmented appearance will be a disadvantage when using the Chopped mode with fast sweep rates. Additional information about both modes is included later in this section under "Dual Trace Operation".

GENERAL OPERATING INFORMATION

Signal Input Connections

Ordinary unshielded test leads can sometimes be used to connect the Type 3A3 to a signal source, particularly when a high-level, low-frequency signal is monitored at a low-impedance point. However, when any of these factors is missing, it becomes increasingly important to use shielded signal cables. In all cases, the signal-transporting leads should be kept as short as practical.

When making single-ended input measurements, be certain to establish a common-ground connection between the instrument under test and the Type 3A3. The shield of a coaxial cable is normally used for this purpose.

Differential measurements require no common-ground connection[1] and, therefore, are less susceptible to interference by ground-loop currents. Some problems with stray magnetic coupling into the signal-transporting leads can also be minimized by using a differential rather than a single-ended measurement. These considerations are discussed later in this section under "Differential Operation".

It is always important to consider the signal-source loading and the resulting change in the source operating characteristics due to the signal-transporting leads and the input circuit of the Type 3A3. The circuit at the input connectors can normally be represented by a 1-megohm resistance to ground paralleled by 47 pf. A few feet of shielded cable may increase the parallel capacitance to 100 pf or more. In many cases, the effects of these resistive and capacitive loads are not negligible, and it may be desirable to minimize them through the use of an attenuator probe.

Attenuator probes not only decrease the resistive and capacitive loading of a signal source, but also extend the measurement range of the Type 3A3 to include substantially higher voltages. Passive attenuator probes having attenuation factors of X10, X100, and X1000, as well as other special-purpose types, are available through your Tektronix Field Engineer or Field Office.

Some measurement situations require a high-resistance input to the Type 3A3 without the signal loss that would result from the use of a passive attenuator probe. This problem may be solved by using a cathode-follower probe such as the P500CF or the floating input provision of the Type 3A3.

The floating input provision applies only to dc-coupled signals which permit the use of the .1 mVOLTS through 10 mVOLTS positions of the VOLTS/DIV switch. Since no input attenuator is used at these switch positions, the internal grid-return resistor alone establishes the 1-megohm input resistance. This resistor can be disconnected by removing a special wire link from the attenuator etched wiring board (see Fig. 2-1). The signal source must then provide a dc path for the tube grid current.

The grid current is typically less than 1 nanoampere, but may be several times higher depending upon the parameters of the individual tube. The signal-source impedance is therefore an important factor since grid current will produce a dc voltage offset. For example, a 1-nanoampere grid current through 10 megohms produces a 10-mvolt offset; this may result in a significant error where small signal voltages are of concern.

The high-frequency response will also depend upon the signal-source impedance since various shunt capacitances between the source and the input grid must charge and discharge through that impedance.

The grid-return link must be connected when a VOLTS/DIV switch position other than those mentioned previously is used so that the attenuation factor of the input attenuators will be correct.

[1]However, the dc plus peak ac voltages on the test points with respect to the chassis potential of the Type 3A3 should be limited to the levels listed in Section 1 under "Common-Mode Rejection" and "Maximum Common-Mode Amplitudes". Higher levels will degrade the common-mode rejection ratio.

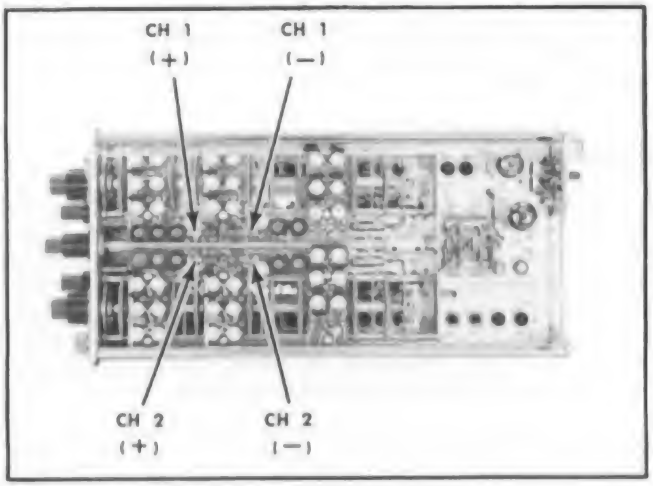


Fig. 2-1 Location of removable wire links for floating input provision.

Display Polarity

Single-ended signals can be applied to either the (+) or (—) input connector. If the (+) input is chosen, positive-going changes in the input signal will cause the trace to be deflected upward and negative-going changes will cause it to be deflected downward. If the (—) input is chosen, input-to-display polarity relationship will be reversed.

A similar polarity relationship exists for differentially applied signals, but pertains to the direction of voltage change at one input with respect to the other rather than with respect to chassis potential.

Deflection Factor

The amount of trace deflection produced by a signal is determined by the signal amplitude, the attenuation factor (if any) of a probe, the setting of the VOLTS/DIV switch, and the setting of the VARIABLE control. The calibrated deflection factors indicated by the VOLTS/DIV switch apply only when the VARIABLE control is set in the detent (CALIB) position.

The range of the VARIABLE control is at least 2.5:1 and provides uncalibrated deflection factors covering the full range between the fixed settings of the VOLTS/DIV switch. The control can be set to extend the deflection factor to at least 25 volts/div.

Voltage Comparison Measurements

Some applications require a set of deflection factors other than the fixed values provided by the VOLTS/DIV switch. One such application is comparison of signal amplitudes by ratio rather than by absolute voltage. To accomplish this, apply a reference signal to either channel of the Type 3A3. Set the VOLTS/DIV switch and VARIABLE control so that the reference display covers the desired number of graticule divisions. Do not change this setting of the VARIABLE control throughout the subsequent comparisons. The setting of the VOLTS/DIV switch can be changed, however, to

accomodate large ratios. In doing so, regard the numbers which designate the switch position as ratio factors rather than voltages.

Differential Operation

The Type 3A3 differential input provisions may be used to eliminate interfering signals such as ac line-frequency hum. Single-ended measurements sometimes yield unsatisfactory information because of hum resulting from ground-loop currents between the oscilloscope and the device under test. In other cases, it may be desirable to eliminate a dc voltage by means other than the use of a dc-blocking capacitor which would limit low-frequency response.

These limitations of single-ended measurements are virtually eliminated in differential measurements. A differential measurement is made by connecting each of the two inputs of one channel to selected points in the test circuit. Since the chassis of the Type 3A3 need not be connected in any way to the test circuit, there are few limitations to the selection of these test points.

The oscilloscope display will indicate only the voltage difference between the two test points. Other signals which may exist between the individual test points and the chassis of the Type 3A3 will be of equal phase and amplitude and therefore do not constitute a difference signal between the test points. Nondifference signals such as this are referred to as "common-mode" signals.

The ability of the Type 3A3 to reject common-mode signals is indicated by the "common-mode rejection ratio". This ratio is at least 50,000:1 at the input connectors for the seven highest sensitivities from dc to 100 kc when the inputs are dc coupled. To show the significance of this characteristic, assume that a single-ended input signal consists of unwanted 60-cps hum at 10 volts peak-to-peak due to ground-loop currents and a desired signal at 10 mvolts peak-to-peak. If the operator attempts to display the desired signal with the VOLTS/DIV switch set at 2 mVOLTS, the 60-cps hum would produce a deflection equivalent to 5000 major graticule divisions and thus no useful information about the 10-mvolt signal could be obtained.

If the same 10-mvolt signal is monitored differentially so that the 60-cps hum signal is in common-mode at the inputs, no greater than one part in 50,000 of the common-mode signal would appear in the display. Thus, the desired signal would produce a display amplitude of 5 major graticule divisions with no more than 0.1 division of interference due to the common-mode signal.

There are a number of factors which can degrade the common-mode rejection ratio of the Type 3A3. The principal requirement for maximum rejection is for a common-mode signal to arrive at the grids of the two input tubes in precisely the same form. For example, a difference of only 0.01% in the attenuation factors of the two input attenuators may reduce the rejection ratio to 10,000:1. Likewise, any difference between the two signal-transporting leads which connect the test circuit to the Type 3A3 will degrade the rejection ratio; ordinary attenuator probes may reduce the rejection ratio to 100:1 or less. However, P6023 Probes have adjustable attenuation factors which permit them to be used with minimum reduction in the common-mode rejection ratio.

Outside influences such as magnetic fields can also degrade the performance, particularly when low-level signals are involved. This type of interference can be minimized by using the same type of signal-transporting lead for each input. Moreover, where an interfering magnetic field cannot be avoided, the two leads should be equally exposed to the field, if possible, by taping or twisting them together throughout most of their length. Low-frequency measurements can be similarly protected by using a shielded cable which contains a twisted pair of conductors.

Differential measurements are also useful for monitoring any push-pull signal regardless of whether interfering signals are present or not.

P6023 Probes

The following is recommended when using P6023 Probes for differential measurements:

1. Connect one probe for single-ended operation. Obtain a triggered display of an appropriate square-wave signal such as that from the oscilloscope amplitude calibrator. Adjust the probe attenuation for correct deflection sensitivity; then compensate the probe for proper square-wave response.
2. Connect the second probe and apply the square-wave signal to both probes at 100 volts peak-to-peak. Obtain a free-running sweep and adjust the attenuation of the second probe for maximum low-frequency cancellation. This is indicated by elimination of the two-trace appearance, resulting in one trace of minimum thickness.
3. Adjust the compensation of the second probe to minimize the amplitude of the differentiated pulses on the trace.
4. The probes are now ready for use at any sensitivity which employs the particular input attenuator used during steps 2 and 3. Whenever it is necessary to use a different input attenuator, steps 2 and 3 must be repeated for that attenuator. The input sensitivity group associated with each of the four attenuators is listed in Table 2-1.

TABLE 2-1

VOLTS/DIV Switch	Input Attenuator
.1 mVOLTS through 10 mVOLTS	X1
20 mVOLTS through .1 VOLTS	X10
.2 VOLTS through 1 VOLTS	X100
2 VOLTS through 10 VOLTS	X1000

Dual-Trace Operation

A partial demonstration of dual-trace operation is included in "First-Time Operation" near the beginning of this section. The choice of alternate or chopped dual-trace operation may be made from the following discussions and Table 2-2.

Displaying Two Nonrepetitive Signals. The Chopped Mode of operation provides good display resolution of nonrepetitive signals using sweep rates as fast as 0.1 msec/div. At this

sweep rate, each trace will consist of about 250 segments. One-channel operation should be used when faster sweep rates are required.

Displaying Two Repetitive Signals Either Chopped or Alternate mode can be used to display repetitive signals. The use of Chopped mode is generally confined to low-frequency signals, but can be used throughout the bandwidth of the instrument. The only limitation is that the trace segments may become objectionably obvious with high sweep rates when there is a harmonic relationship between the triggering signal and the trace-switching signal. The use of Alternate mode is generally confined to signals of 250 cps or higher, and sweep rates of 5 msec/div or faster. With lower frequencies or slower sweep rates, the alternation of the traces may be objectionably obvious.

TABLE 2-2

Internal Triggering Recommendations

Signals	3A3 MODE Switch	3A3 TRIGGER Switch	Time-Base Trigger Coupling
Two of same or harmonically-related frequency, 250 cps and above.	ALTER	CH 1 or CH 2, whichever bears the lower frequency.	Ac
Two of the same or harmonically - related frequency, anywhere within full bandwidth.[2]	CHOP	CH 1 or CH 2	Ac, dc, or ac fast, as required.
Two of dissimilar and nonharmonically - related frequency, 1 kc and above.	ALTER	COMP	Ac fast only.[3]
Two one-shot signals. Sweep rate limited to 0.1 mesc/div maximum.	CHOP	CH 1 or CH 2, whichever bears signals of earliest occurrence.	Ac, dc, or ac fast, as required.

[2]Occasionally the signals will be harmonically related to the chopping rate so that sweep rates above 0.1 msec/div will make the trace segments objectionably obvious.
[3]With time bases which do not provide ac-fast trigger coupling, it may be difficut or impossible to obtain a stable display.

X-Y Operation

The Type 3A3 can be operated in X-Y configuration with any 2- or 3-Series plug-in unit[4] except sampling units and certain time-base units which have no provisions for externally applied deflection signals. However, in applications involving precise phase-angle measurements between two sine-wave signals of the same frequency, a Type 3A3 should be used only with another Type 3A3. See Fig 2-2.

Two X-Y operated Type 3A3 plug-in units typically exhibit less than 2° output phase difference with in-phase 100-kc input signals (with the BANDWIDTH switch set to HI). Moreover, the two units can be specially calibrated for 0° phase difference at any particular frequency up to 500 kc (see step 27 in the Calibration Procedure, Section 5). If the Type 3A3 is operated with a unit of a different type, an output phase difference of some what more than 2°at 100 kc should be expected.

For many applications, the plug-in unit deflection sensitivities for each axis should be checked and adjusted, if necessary. Among the applications where this is not required is frequency comparison (Lissajous displays).

[4]Does not apply to Tektronix Type 565 and RM565 Oscilloscopes which use only vertical plug-in units. However, external horizontal deflection signals can be applied for applications other than precise phase-angle measurements.

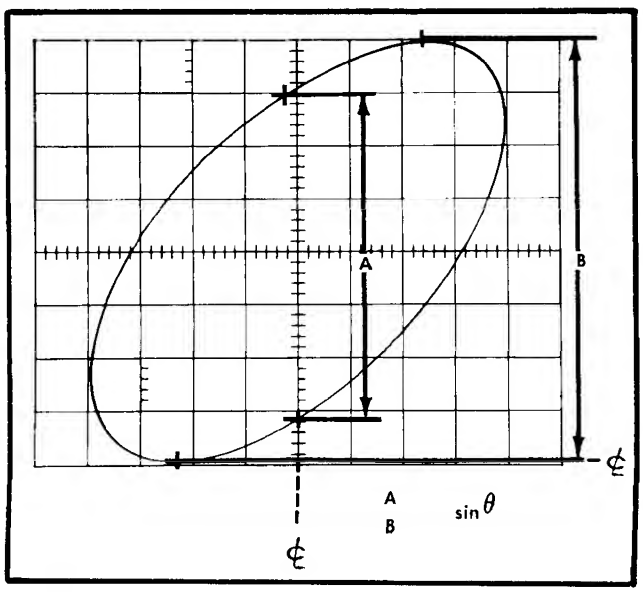


Fig. 2-2. X-Y method of calculating phase difference θ of two sine waves.

Dual-X-Y displays can be obtained using two Type 3A3 plug-in units or one Type 3A3 and two channels of a Type 3A74. The left-hand unit should be set for Chopped operation and the right-hand unit for Alternate operation.

AUXILIARY FUNCTIONS

Output Cathode Followers

Pins 11 and 12 of the Type 3A3 interconnecting plug provide a ground-referenced, low-impedance, differential output signal which can be selected from either input amplifier or from the common output amplifier by setting the TRIGGER switch. Jacks may be installed in the rear panel of the oscilloscope for access to these output (BNC jacks recommended: Type UG1094/U, Tektronix part number 131-126.)

The output signals may be used either single-ended or differentially for applications which include driving slave oscilloscopes and X-Y plotters. Load resistance per side must be 100 k or greater and load capacitance should be minimized since the output frequency response decreases as load capacitance increases.

SECTION 3

CIRCUIT DESCRIPTION

Introduction

This portion of the manual contains a description of the Type 3A3 circuitry keyed to the block diagram and schematics in Section 6.

INPUT AMPLIFIERS

The following description pertains to both the Channel 1 and Channel 2 Input Amplifiers, but circuit reference numbers for Channel 1 are used.

The (+) input coupling switch (SW101) permits selection of ac or dc signal coupling, or grounding of the attenuator input without grounding the signal source. The GND position provides a ground reference for the unused grid in single-ended input applications. It also permits ac-coupling capacitor C101 to be charged or discharged while the amplifier is insensitive to transients. The output end of C101 is grounded and R101 is placed between the (+) connector and the input side of C101 to limit charging current and source loading.

The VOLTS/DIV switch provides input attenuators ranging from X1 to X1000. Several desirable characteristics are provided by these attenuators:

1. The input time constant is established at about 47 μsec and equalized at all settings of the VOLTS/DIV switch for both input connectors. In the (+) X1 position, this is accomplished by adjusting C109 with respect to R113. C105A, C106A, and C107A serve the same purpose for the other positions.

2. The resistive (low-frequency) attenuation ratios of the (+) and (—) attenuators are equalized by adjusting R105F, R106F, and R107F.

3. Attenuator compensation and equalization of the (+) and (—) attenuator compensations are obtained by adjusting C105C, C205C, C106C, C206C, C107C, and C207C.

A V114 grid current of several hundred picoamperes is normal and produces a voltage drop of several hundred μvolts across R113. GRID CURRENT ZERO R110 is set to restore the grid voltage to zero in the presence of the R113 voltage drop. For special applications, the link between the grid of V114 and R113 may be removed to provide a substantially higher input resistance than the 1 megohm of R113 (with sensitivities of 10 mvolts/div and higher). R113 must be connected when the X10, X100, or X1000 attenuators are used so that the attenuation ratios will be correct.

D113 limits V114 grid current during tube warmup.

V114-Q114 and V214-Q214 form a cascode paraphase or cascode differential amplifier, depending on whether one or both inputs are used. For the ampilifier to operate in a true differential manner, static and dynamic balances must be closely controlled. The first consideration is dc balance with zero volts on the grid of each tube. This involves two front-panel controls: RANGE and ATTEN BAL.

RANGE control R692 (shown on the Switching and Output Amp diagram) provides a differential adjustment of the V114 and V214 filament voltages. This control is set so that the plate currents (in part, a function of cathode temperature) are approximately equal when the grids are at zero volts.

ATTEN BAL R235 has the same purpose and effect as the RANGE control, but with a narrower range of adjustment and no thermal time lag. Current is added to the Q114 emitter and diverted from the Q214 emitter (or vice versa) so that the collector voltages of these transistors are equalized.

Q128 provides an essentially constant 6 ma; 4 ma is divided between V114 and V214 according to their grid voltages, and the remaining 2 ma passes through R124 to be absorbed by Q118. The voltage drop across R124 is constant because of the constant current; therefore, the Q114-Q214 base voltages are held constant with respect to the tube cathodes.

The dynamic range of the amplifier is limited to grid voltage differences of about 250 mvolts. This limit does not pertain to the grid voltages with respect to chassis potential, but only with respect to one another. Common-mode signal amplitudes (signals of equal amplitude applied in phase to the (+) and (—) inputs) up to $\pm$10 volts peak at the grids will produce essentially no change in the division of the common-cathode current between the tubes. The common-cathode voltage will, however, follow the common-mode signal in the manner of a single cathode follower. This voltage variation causes an essentially equal variation at the Q114-Q214 bases so that the V114 and V214 plate-to-cathode voltages remain constant. This virtually eliminates any change in current division between the tubes due to differences in their parameters.

Since the impedance of the common-cathode current source is finite, a small but significant change in the total common-cathode current will occur. The additional current probably will not divide between the tubes in the same proportions as the basic current because of differences in mutual conductance. The current division is corrected by proper setting of DIFF BAL R131 so that current is inserted or removed (depending on instantaneous common-mode polarity) in the correct proportions at the emitters of Q114 and Q214.

C116 and C216 provide a small amount of positive feedback to neutralize the effects of tube interelectrode capacitances.

C214 supplements the stray capacitances in the V214 plate circuit to provide a predictable load time constant. This time constant is important only in the presence of common-mode signals and must then essentially equal the V114 plate-circuit time constant. Thus, C114 is adjusted to equalize these time constants so that maximum common-mode rejection is maintained as frequency increases.

C115 and C215 equalize the Q114 and Q214 collector time constants at stable values for optimum amplifier characteristics for both common-mode and non common-mode signals.

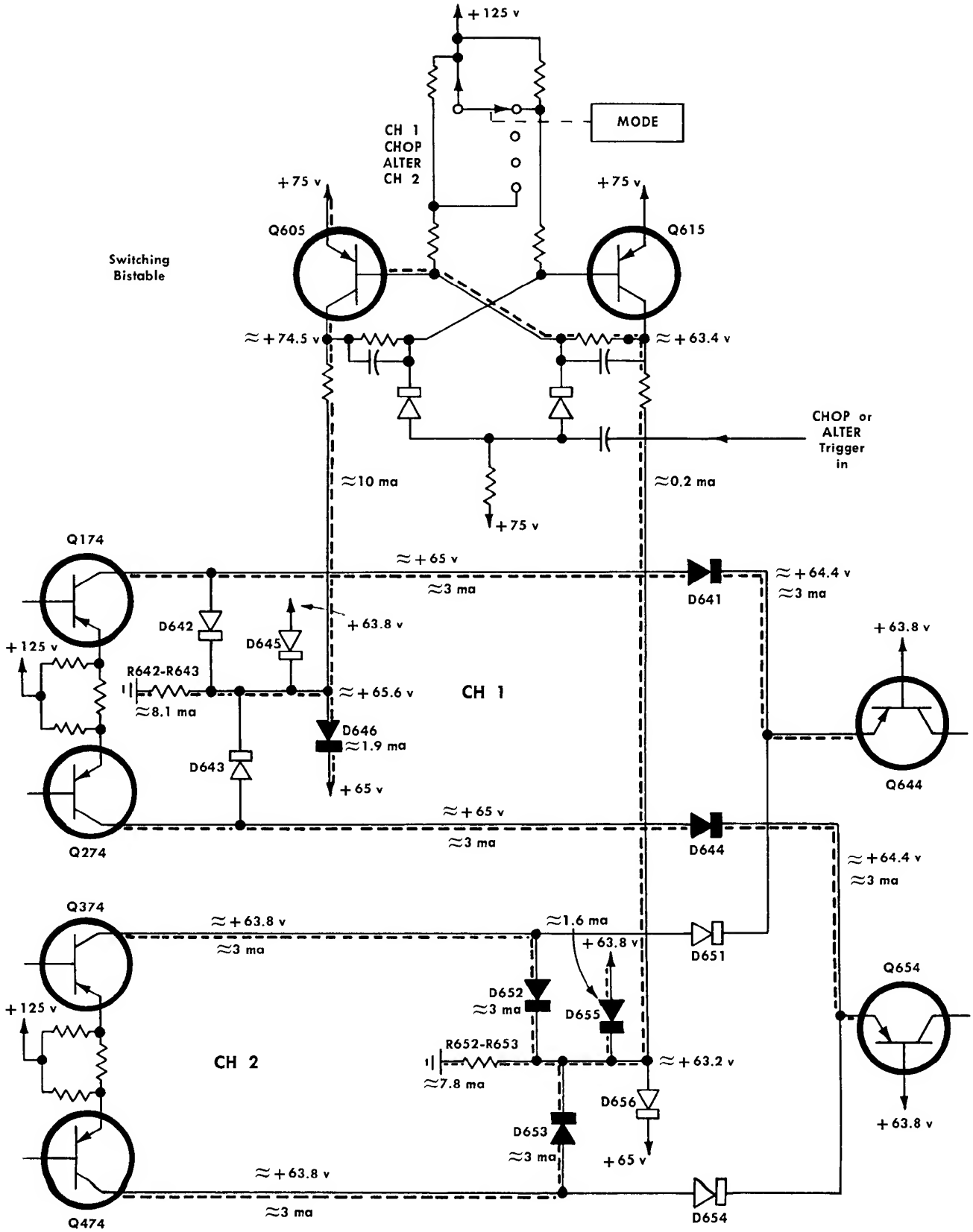


Fig. 3-1. Channel switching voltages and currents.

Emitter followers Q143 and Q243 provide interstage isolation.

The Q154-Q254 stage includes frequency-compensated degenerative common-emitter coupling. VAR DC BAL D159 is set so that the Q154 and Q254 emitter currents will be equal when their emitter voltages are equal. With this balanced condition, there is no current between emitters through the attenuator components.

A signal will have opposite polarities at the Q154 and Q254 bases and the emitters will follow the signal voltages. A potential difference then exists between the emitters, and current is diverted from one to the other through the attenuator elements. The magnitude of the current diversion is determined by the potential difference and the impedance of the attenuator elements according to Ohm's law. The total emitter current change is a combination of the diverted current and the R154-R254 current change.

C151 can be switched into the degenerative network on the four most sensitive ranges. Since the impedance of a capacitor is theoretically infinite at dc, there is essentially no current diversion and low-frequency information such as drift is greatly attenuated.

The common emitter impedance decreases with frequency due to C251 in parallel with the resistive elements of the attenuator. This extends and permits optimizing the amplifier high-frequency response.

C260 shunts some high-frequency current away from the Q163 and Q263 bases to limit the compensation in the common emitter network of the Q154-Q254 stage. When the BANDWIDTH switch is set to LO, C261 parallels C260 and limits the bandwidth to about 5 kc.

Q163 and Q263 are conventional emitter followers. The signal for the Trigger Amplifier is taken from these emitters and, therefore, is essentially unaffected by the POSITION, GAIN, and VARIABLE controls. The signal is available to the Trigger Amplifier at all times regardless of the setting of the MODE switch.

The degenerative common-emitter coupling in the Q174-Q274 stage is similar to that in the Q154-Q254 stage. VARIABLE control R275 permits changing the Input Amplifier gain over a range of at least 2.5:1. Internal GAIN control R175 permits matching the gain of the Channel 1 Input Amplifier to that of Channel 2, and at the proper magnitude for the Output Amplifier.

Since the Q174 and Q274 collectors drive low-impedance points in the Output Amplifier, there is essentially no signal voltage at their collectors. The dc portion of the current signal can be altered by resetting the POSITION control. When the dc portions are equal, the trace should be centered on the crt.

SWITCHING AND OUTPUT AMPLIFIER

The conduction state of Switching Bistable Q605-Q615 determines which Input Amplifier will be connected to the Output Amplifier.

Fig. 3-1 shows the circuit conditions when the MODE switch is set to CH 1. With Q605 on, the R642-R643 current in Channel 1 is assumed by the transistor and the voltage across the resistors is clamped by D646. This clamped voltage is sufficiently positive with respect to the Q644-Q654 emitters to reverse bias D642-D643 and forward bias D641-D644. Thus, the Channel 1 current signal passes to the Output Amplifier. Conversely, Q615 assumes none of the R652-R653 current in Channel 2 and the voltage across the resistors is clamped by D655. This clamped voltage is sufficiently negative with respect to the Q644-Q654 emitters to forward bias D652-D653. This reduces the Q374-Q474 collector voltages slightly and reverse biases D651-D654. Thus, the Channel 2 current signal is prevented from reaching the Output Amplifier.

When the MODE switch is set to CH 2, the conduction state of the Q605-Q615 Switching Bistable is reversed. The Channel 1 current signal is then diverted by D642 and D643 while the Channel 2 signal passes to the Output Amplifier through D651 and D654.

The CHOP and ALTER positions of the MODE switch permit the Q605-Q615 Switching Bistable to be electronically switched by pulses from the Q625-Q635 Driver Multi.

The Driver Multi is locked in an inoperative state when the MODE switch is set to either CH 1 or CH 2. But in the Chopped mode, the Driver Multi is astable and provides switching pulses to the Switching Bistable through T621 at intervals of 2 to 3 μsec. Thus, the Output Amplifier signal alternates between Channel 1 and Channel 2 at a rate sufficiently high to produce a display which appears to consist of simultaneous continuous traces for both channels (with sweep rates of 0.2 msec/div and slower).

The Driver Multi signal from the collector of Q635 is coupled to the Crt Circuit of the oscilloscope to turn off the display for a brief interval while the Type 3A3 switches channels (chopped blanking).

In the Alternate mode, the Diver Multi is monostable; Q625 is normally off and Q635 is on. A pulse is received via pin 3 of the plug-in unit interconnecting plug at the completion of each time-base sweep. This pulse momentarily switches the Driver Multi, causing the Switching Bistable to change states. The display then shifts from one channel to the other for the duration of the next sweep. The Driver Multi reverts to its normal state long before the completion of the subsequent sweep.

The Sync Pulse Output connection at pin 4 of the plug-in unit interconnecting plug permits the Type 3A3 to be used for dual X-Y displays with some other multichannel plug-in units equipped with similar pin 4 connections (e.g. Type 3A74). The left-hand unit would be operated in Chopped mode to provide chopped blanking, and the right-hand unit in Alternate mode. The unit operating in Chopped mode would produce a rate-determining output signal at pin 4 of its connector. This signal would enter the second unit through pin 3 of its connector. Thus, the second unit would alternate between channels at the chopping rate of the first.

The Output Amplifier is driven by common-base stage Q644-Q654. Q644 and Q654 are the output halves of two cascode amplifiers operating differentially. The input halves are either Q174 and Q274 or Q374 and Q474 depending upon which channel is switched on.

The degenerative common-emitter coupling between Q664 and Q674, which includes the CALIBRATE control R665, is similar to that described for the Q154-Q254 stage of the Channel 1 Input Amplifier. V674A and B isolate transistors Q664 and Q674 from the high output dc level of the amplifier.

TRIGGER AMPLIFIERS

Q504 and Q514 form a differential amplifier employing degenerative common-emitter coupling. R511 is adjusted so that the output from the cathode followers will be balanced when the Q504-Q514 input is balanced. R509-R523 and R519-R527 are connected between the collectors and R525 to permit adjustment of the cathode follower output dc level to zero volts. The fixed and variable capacitors such as C508 and C509 compensate for the high-frequency loading effect of the coaxial cables which carry the signal to the output cathode followers.

SECTION 4

MAINTENANCE

PREVENTIVE MAINTENANCE

Cleaning the Interior

Internal cleaning should precede calibration since the cleaning process could alter the setting of certain calibration controls.

One way to clean the interior is by vacuum and/or low-pressure compressed air (high-velocity air could damage certain components). Hardened dirt may be removed with a soft paint brush, cotton-tipped swab, or cloth dampened with a water and mild detergent solution.

Lubrication

The contacts on the plug-in unit interconnecting jacks and plugs should be lightly lubricated with an oil of the type used on rotary-switch contacts (e.g. Beacon No. 2008-1). To extend the life of the contacts, clean and relubricate if the oil becomes contaminated with abrasive dust.

Visual Inspection

The instrument should be inspected occasionally for such defects as poor connections, broken or damaged ceramic terminal strips, imporperly seated tubes or transistors, and heat-damaged parts. The remedy for most visible defects is obvious. But damage from overheating is usually a symptom of less obvious trouble and unless the cause is determined before parts are replaced, the damage may be repeated.

Tube and Transistor Checks

Periodic preventive maintenance checks on the tubes and transistors used in the instrument are not recommended. The circuits within the instrument generally provide the most satisfactory means of checking tube or transistor useability. Performance of the circuits is thoroughly checked during recalibration so that substandard tubes and transistors will usually be detected at that time.

Recalibration

To insure accurate measurements, the instrument calibration should be checked after each 500 hours of operation or every six months if used intermittently. Complete calibration instructions are contained in Section 5.

The calibration procedure can be helpful in isolating major troubles in the instrument. Moreover, minor troubles not apparent during regular operation may be revealed and corrected during calibration.

Cleaning the Front Panel

Loose dust may be removed with a cloth and a dry paint brush. Water and mild detergents such as Kelite or Spray White may be used, but abrasive cleansers should not.

CORRECTIVE MAINTENANCE

General Information

Certain parts in the instrument are best replaced if definite procedures are followed as outlined in the following paragraphs.

Many electrical components are mounted in a particular way and selected for a particular physical size and shape to reduce or control stray capacitance. After repair, portions of the instrument may require recalibration; see Section 5.

Standard Parts

Many components in the instrument are standard electronic parts available locally. However, all parts can be obtained through your Tektronix Field Engineer or Field Office. Before purchasing or ordering, consult the parts list to determine the value, tolerance, and rating required.

Special Parts

Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. These and most mechanical parts should be ordered directly from your Tektronix Field Engineer or Field Office. See "Parts Ordering Information" and "Special Notes and Symbols" on the first page of Section 6.

Soldering

Special silver-bearing solder is used to establish a bond to the ceramic terminal strips in Tektronix instruments. This bond may be broken by repeated use (especially if ordinary tin-lead solder is used) or by excessive heating. Solder containing about 3% silver is recommended. Solder of this type is usually available locally, but may be purchased in one-pound rolls through your Tektronix Field Engineer or Field Office. Order by part number 251-514.

Soldering to Ceramic Strips:

1. Use a wedge-shaped soldering-iron tip about 1/8-inch wide. This will allow you to apply heat directly to the solder in the terminal without touching the ceramic, thereby reducing the amount of heat required.
2. Maintain a clean properly tinned tip.
3. Use a hot iron for a short time. A 50- to 75-watt iron having good heat storage and transfer properties is adequate.
4. Avoid putting pressure on the strip with the soldering iron or other tools. Excess pressure may cause the strip to crack or chip.

Ceramic Terminal Strips

Fig. 4-1 shows an assembled ceramic terminal strip.

Replacement strips with studs attached are supplied under a single part number and spacers under another number. The original spacers may be reused if undamaged.

Usually, a strip can be pried out of the chassis or pulled out with a pair of pliers. In some cases, you may choose to use a hammer and punch to drive out the studs from the opposite side of the chassis.

When the damaged strip has been removed, place new (or used, but undamaged) spacers in the chassis holes. Then, carefully force the studs of the new strip into the spacers until they are completely seated. If necessary, use a soft-faced mallet, tapping lightly directly over the stud area of the strip.

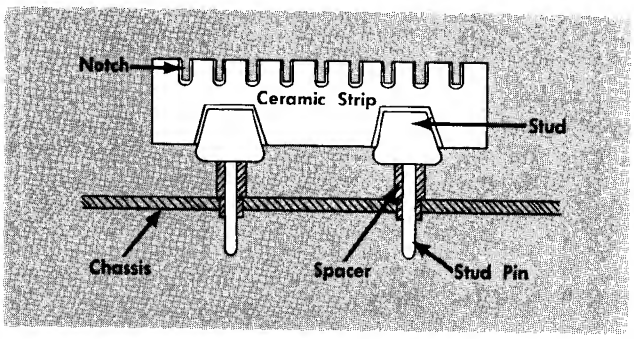


Fig. 4-1. Ceramic terminal strip assembly.

Switch Replacement

Individual wafers normally are not replaced in switch assemblies. Replacement switches may be ordered from Tektronix either unwired or with the associated wires and components attached. See the parts list in Section 6.

When soldering leads to a switch, do not let solder flow around and beyond the terminal rivet as this may destroy the contact spring tension.

Tubes and Transistors

Tubes and transistors should not be replaced unless actually defective. However, temporary substitution is often the fastest and best way to detect a defective tube or transistor. Before substituting a tube or transistor, it is suggested that circuit conditions be checked to be certain that a replacement tube or transistor will not be subject to damage. In some cases, these checks will also show whether or not the tube or transistor is at fault.

When circuit conditions are known to be safe, install a tube or transistor of the same type which is known to be good and check for proper operation. If the original tube or transistor is thus proved acceptable, return it to the socket from which it came to avoid unnecessary recalibration.

It may be necessary to select from several tubes to obtain a replacement for the V114, V214, V314 or V414 position. It is recommended that prospective replacement tubes be aged for 50 to 100 hours before the selection is made. Aging may be accomplished in an aging rack or in the Type 3A3. Four factors should then be considered in selecting the replacement tube.

1. Dc balance. The input stage should balance with the RANGE control set within the center 50% of its range.
2. Grid current. Should be less than 1 nanoampere.
3. Minimum microphonics.
4. Ac balance. The dynamic characteristics of the two input tubes should be adequately matched to provide the required common-mode rejection ratio.

These characteristics may be verified by completing the following calibration steps in Section 5 for the affected channel: 1, 2, 4, 6, 12, 16, 18, and 20. When an adequate tube has been selected, it is suggested that steps 1 through 25 of the calibration procedure be performed.

Troubleshooting Aids

This manual and the instrument contain many features intended to speed and simplify maintenance. A block diagram which provides an overall picture of instrument operation is included with the schematic diagrams in the back of this manual. The schematic diagrams give the circuit reference number for each electrical component as well as important operating voltages, signals, and conditions for their measurement.

The instrument contains a number of stable metal-film resistors identified by their gray background color and color coding. If a resistor has three significant figures and a multiplier, it will be EIA color coded. If it has four significant figures and a multiplier, the value will be printed on the resistor. For example, a 333 k resistor will be color coded, but a 333.5 k resistor will have its value printed on the resistor body. The color coding sequence is shown in Fig. 4-2 and Table 4-1.

TABLE 4-1

Color Code Sequence

Color	1st Sig. Fig.	2nd Sig. Fig.	3rd Sig. Fig.	Multiplier	(±)% Tolerance
Black	0	0	0	1	-
Brown	1	1	1	10	1
Red	2	2	2	100	2
Orange	3	3	3	1,000	-
Yellow	4	4	4	10,000	-
Green	5	5	5	100,000	0.50
Blue	6	6	6	1,000,000	0.25
Violet	7	7	7	10,000,000	0.10
Grey	8	8	8	100,000,000	0.05
White	9	9	9	1,000,000,000	-
Gold				0.1	5
Silver				0.01	-
No Color					10

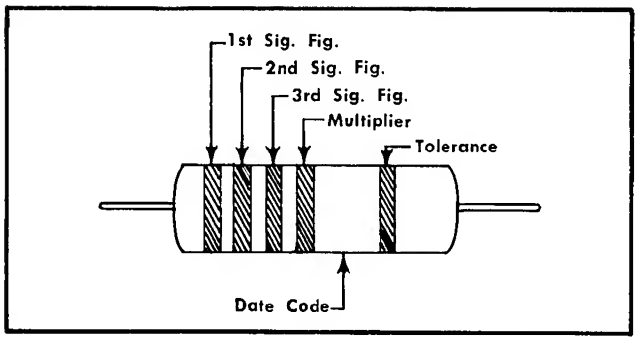


Fig. 4-2. Standard EIA color code for metal-film resistors.

Switch wafers shown on the circuit diagrams are coded to indicate the physical positions of the wafers on a rotary switch. The number portion of the code refers to the wafer position as counted from the front or driven end of the switch shaft. Letters F and R indicate whether the front or rear of the wafer is used to perform the particular switching function.

Fig. 4-3 identifies the polarity of the various diode types used in Tektronix instruments.

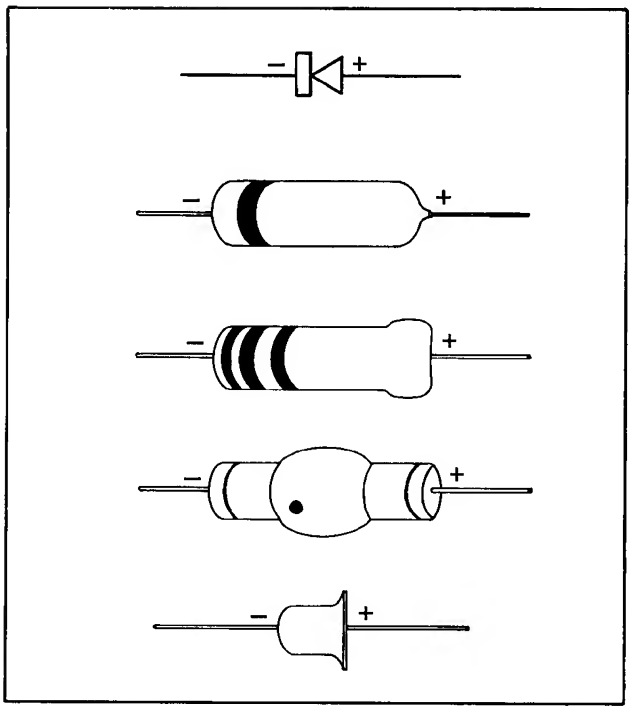


Fig. 4-3. Diode polarities.

NOTES

SECTION 5

CALIBRATION AND VERIFICATION

Introduction

The Type 3A3 is a stable instrument which will provide many hours of trouble-free operation. However, to insure measurement accuracy, it is suggested that you recalibrate the instrument after each 500 hours of operation, or every six months if used intermittently. It will also be necessary to recalibrate certain sections when tubes, transistors, or other components are replaced.

The title of each numbered step in this procedure begins with either "Adjust" or "Check", thereby identifying the step function as calibration or verification. The continuity of the procedure will not be disrupted if you choose to skip the "Check" step or steps between two "Adjust" steps. The "Adjust" steps, however, should be completed in the order given and none should be skipped. Remember that you can be certain of proper overall operation only when all steps in the procedure have been completed.

Many steps in this procedure will be used twice; once for each channel. These steps have the form: "Adjust C116 (C316) for - - - ". This means that only C116 is to be adjusted when the step is used the first time. When the step is performed later for the other channel, only (C316) is to be adjusted.

NOTE

The performance standards described in this section of the manual are provided strictly as a guide to calibration and should not be construed as advertised performance specifications. However, if the instrument performs within the guide tolerances given in this procedure, it will also perform as listed in Section 1 of this manual.

Equipment Required

1. Tektronix 560-Series Oscilloscope (except the Type 560). Steps involving X-Y operation of two Type 3A3 plug-in units cannot be performed in the Type 565 or Type RM565 Oscilloscopes. The oscilloscope used must be calibrated.
2. Tektronix rigid plug-in unit extension. Tektronix part number 013-034.
3. Tektronix 2B- or 3B-Series time-base plug-in unit. This unit must be calibrated. (Not required with Type 565 or Type RM565 Oscilloscopes.)
4. Autotransformer such as Variac or Powerstat. Required characteristics: Output voltage range covering the full line-voltage range of the oscilloscope (item 1). Rating of at least 800 volt-amperes.
5. Ac voltmeter calibrated in rms for monitoring the autotransformer output. Required characteristics: 2% accuracy over the full line-voltage range of the oscilloscope.
6. Amplitude calibrator such as that which is part of a Tektronix Type 561A Oscilloscope. Required characteristics: Square-wave output with amplitudes ranging from at least 0.5 mvolt to 50 volts peak-to-peak in a 1, 2, 5 sequence. The actual calibrator amplitudes should be determined within about 0.25% before use. Calibrators in most Tektronix oscilloscopes can be checked by disabling the multivibrator so that the output will be dc voltages which correspond to the peak level of the various square-wave amplitudes. The output should be loaded by 1 megohm and the voltages checked with a high-impedance dc voltmeter which is accurate to about 0.1% of reading. Most Tektronix amplitude calibrators need be checked only through the range of 0.1 to 100 volts since these values will permit calculation of the accuracy of all lower voltages. Record the accuracy of each voltage as a + or — percentage for use during steps 8 through 13 of the Type 3A3 Calibration Procedure.
7. Square-wave generator such as the Tektronix Type 105. Required characteristics: Output frequencies of 100 cps, 1 kc, 2.5 kc, and 25 kc. Output impedance of 600 Ω or less. Output amplitude of about 100 volts peak-to-peak when unterminated. Risetime of 1 μsec or less when unterminated.
8. Tektronix 50 Ω termination unit. Tektronix part number 011-049 (BNC) or 011-045 (UHF).
9. (3) Tektronix 50 Ω X10 coaxial attenuators. Tektronix part number 010-314 (BNC) or 011-031 (UHF).
10. Sine-wave generator such as the Hewlett-Packard Model 200CD. Required characteristics: Frequency of 100 kc. Output voltage variable from 60 mvolts (using external attenuators, if necessary) to at least 10 volts peak-to-peak.
11. Tektronix input time constant standardizer 47 pf. Tektronix part number 011-068 (BNC).
12. (2) Tektronix X10 attenuator probes such as P6006.
13. Test oscilloscope such as the Tektronix Types 561A/2A63/2B67. Required characteristics: Vertical response from dc to at least 100 kc. Vertical sensitivity of at least 50 mvolts to 10 volts/div.
14. (Optional) A second Tektronix Type 3A3. Used for checks and adjustments applicable only to two Type 3A3 units which are to be used for X-Y displays.
15. Coaxial cables, coaxial adapters, and tools as required.

Preliminary Instructions

1. Remove the side covers from the oscilloscope.
2. Install the Type 3A3 on an extension (see "Equipment Required", item 2) in the left-hand compartment of the oscilloscope. Install a time-base unit in the right-hand compartment of the oscilloscope (not applicable to Tektronix Type 565 or Type RM565 Oscilloscopes).

3. Connect the oscilloscope and ac voltmeter (see "Equipment Required", item 5) to the autotransformer output (see "Equipment Required", item 4).
4. Connect the autotransformer to the appropriate line-voltage source and set for an output near the center of the line-voltage range for which the oscilloscope is wired (see tag on oscilloscope rear panel).
5. Set the Type 3A3 front-panel controls as follows:

Channel 1 and Channel 2	
VOLTS/DIV	10 mVOLTS
VARIABLE	Slightly clockwise from the detent (CALIB) position.
POSITION	Midrange
ATTEN BAL	Midrange
AC STAB	OFF
AC GND DC (all)	GND
Common controls	
MODE	CH 1
TRIGGER	COMP
BANDWIDTH	LO
CALIBRATE	Midrange

6. Set the oscilloscope INTENSITY control fully counterclockwise. Turn on the instrument power and allow at least 15 minutes for warmup.
7. Set the time-base controls for free running sweeps at 0.5 msec/div. Set the oscilloscope INTENSITY control to obtain a trace on the crt.

NOTE

Photographs on foldout pages following the schematics in the back of this manual show the location of each calibration adjustment.

Procedure

1. Adjust Channel 1 RANGE and ATTEN BAL

NOTE

Steps 1 (a) through 1 (i) comprise a detailed description for correcting a severe misadjustment of the RANGE control followed by the related adjustment of the ATTEN BAL control. Since severe misadjustment is seldom encountered, any simplified adjustment method may be used which will provide the same end result; minimum trace movement as the VOLTS/DIV switch is turned throughout its range with the VARIABLE control set to the detent (CALIB) position.

a. Use the appropriate POSITION control to center the trace.

b. While noting the direction of trace movement, turn the appropriate VARIABLE control clockwise until either the control is in the detent (CALIB) position or the trace is positioned to the top or bottom of the graticule.

c. Recenter the trace by turning the RANGE (front panel) control clockwise to move it upward or counterclockwise to move it downward. The time lag between adjustment and trace movement is normal.

d. If necessary, repeat the adjustment so that the trace is within 1 major division of graticule center with the VARIABLE control in the detent (CALIB) position and with the POSITION control set at midrange.

e. Use the POSITION control to center the trace.

f. Set the VOLTS/DIV switch to 5 mVOLTS and adjust the RANGE control to recenter the trace within about one-half major graticule division. Refine this adjustment with the VOLTS/DIV switch set first at 2 mVOLTS and then at 1 mVOLTS.

g. Set the VOLTS/DIV switch to 10 mVOLTS and repeat steps (e) and (f) until it is possible to change the VOLTS/DIV switch setting from 10 mVOLTS to 1 mVOLTS with a trace shift of less than 1 minor graticule division.

h. Set the VOLTS/DIV switch to .1 mVOLTS and adjust the ATTEN BAL control to recenter the trace.

i. Reset the VOLTS/DIV switch to 10 mVOLTS.

2. Adjust VAR DC BAL R159

a. Adjust VAR DC BAL R159 (R359) so that there is minimum trace movement as the front-panel VARIABLE control is turned throughout its range.

3. Adjust Channel 2 RANGE, ATTEN BAL, and VAR DC BAL R359

a. Set the MODE switch to CH 2 and repeat steps 1 and 2 for the comparable Channel 2 adjustments.

4. Check Channel 2 Noise, Microphonics, and Drift

a. Set the BANDWIDTH switch to HI and the VOLTS/DIV switch to .1 mVOLTS.

b. Check for 0.4 major graticule division or less of noise on the trace.

c. Set the VOLTS/DIV switch to .2 mVOLTS, the AC STAB switch to AC STAB, and the time-base TIME/DIV switch to 10 mSEC.

d. Tap the front panel of the Type 3A3 with the end of one finger and check that the trace deflection due to microphonics is 4 major graticule divisions peak-to-peak or less.

e. Set the VOLTS/DIV switch to 10 mVOLTS, the AC STAB switch to OFF, and the time-base TIME/DIV switch to .5 mSEC.

NOTE

Steps "f" through "i" need be completed for only one channel.

f. Set the power-line autotransformer for 105 vac (or the lower line-voltage limit for which the instrument is wired) and allow about 30 seconds for thermal stabilization.

g. Use the POSITION control to center the trace.

h. Set the autotransformer for 125 vac (or the upper line-voltage limit for which the instrument is wired) and allow 45 seconds for thermal stabilization.

i. Check that the trace is now within one-half major division of graticule center. Failure in this check may indicate improper regulation of the oscilloscope —12.2-volt power supply.

j. Reset the autotransformer for the oscilloscope mid-range operating voltage.

5. Check Channel 1 Noise, Microphonics, and Drift

a. Set the MODE switch to CH 1 and repeat step 4 for Channel 1.

6. Adjust Channel 1 GRID CURRENT ZERO (+) R110 and (—) R210

a. Set the MODE switch to CH 1 and the VOLTS/DIV switch to 1 mVOLTS.

b. Set (+) GRID CURRENT ZERO R110 (R310) and (—) GRID CURRENT ZERO R210 (R410) fully counter-clockwise.

c. Use the POSITION control to center the trace.

d. Set the (+) AC GND DC switch to DC and check that the trace is now no greater than two major divisions from graticule center. This is a check on on uncompensated grid current from V114 (V314) where one major graticule division corresponds to 1 nanoampere. If in excess of this amount, the tube should be replaced with one which has been properly aged.

e. Adjust GRID CURRENT ZERO R110 (R310) so there is essentially no trace movement as the (+) AC GND DC switch is moved back and forth between GND and DC.

f. Set the (+) AC GND DC switch to GND and repeat steps (c) through (e) using R210 (R410) and the (—) AC GND DC switch to check and compensate for the V214 (V414) grid current.

g. Reset the (—) AC GND DC switch to GND.

7. Adjust Channel 2 GRID CURRENT ZERO (+) R310 and (—) R410

a. Set the MODE switch to CH 2 and repeat step 6 for Channel 2.

8. Adjust Channel 2 GAIN R375 and CALIBRATE (front panel)

a. Set the VOLTS/DIV switch to 10 mVOLTS and the the BANDWIDTH switch to HI.

b. Set the amplitude calibrator for 50 mvolts peak-to-peak (see "Equipment Required", item 6).

c. Use coaxial cable to connect the amplitude calibrator output to the channel 2 (—) input connector.

d. Set the (—) AC GND DC switch to DC and use the POSITION control to center the display.

e. Adjust GAIN R375 for 5 major graticule divisions of deflection.

f. Reset the (—) AC GND DC switch to GND.

9. Check Channel 2 Attenuators

a. Set the (—) AC GND DC switch to DC and check for the correct deflection amplitude at the various VOLTS/DIV switch settings according to Table 5-1. Remember to allow for the amplitude calibrator accuracy.

TABLE 5-1

Amplitude Calibrator	VOLTS/DIV Switch	Deflection (Major Graticule Divisions)	Tolerance (Minor Graticule Divisions)
0.5 mv	.1 mVOLTS	5	±0.75
1 mv	.2 mVOLTS	5	±0.75
2 mv	.5 mVOLTS	4	±0.6
5 mv	1 mVOLTS	5	±0.75
10 mv	2 mVOLTS	5	±0.75
20 mv	5 mVOLTS	4	±0.6
50 mv	10 mVOLTS	5	±0.75
0.1 v	20 mVOLTS	5	±0.75
0.2 v	50 mVOLTS	4	±0.6
0.5 v	.1 VOLTS	5	±0.75
1 v	.2 VOLTS	5	±0.75
2 v	.5 VOLTS	4	±0.6
5 v	1 VOLTS	5	±0.75
10 v	2 VOLTS	5	±0.75
20 v	5 VOLTS	4	±0.6
50 v	10 VOLTS	5	±0.75

b. Reset the (—) AC GND DC switch to GND and disconnect the signal cable.

10. Adjust Channel 1 GAIN R175

a. Set the MODE switch to CH 1 and the VOLTS/DIV switch to 10 mVOLTS.

b. Set the amplitude calibrator for 50 mvolts peak-to-peak.

c. Use coaxial cable to connect the amplitude calibrator output to the Channel 1 (—) input connector.

d. Set the (—) AC GND DC switch to DC and center the display.

e. Adjust GAIN R175 for exactly 5 major divisions of deflection. Remember to allow for the amplitude calibrator accuracy.

11. Check Channel 1 Attenuators

a. Repeat step 9.

12. Adjust Channel 1 DIFF BAL R131

a. Terminate the square-wave generator output and connect it to both the (+) and the (—) input connectors. (See "Equipment Required", items 7 and 8).

b. Set the VOLTS/DIV switch to 2 VOLTS and the (—) AC GND DC switch to DC.

c. Set the generator frequency to 100 cps and amplitude for about a 2-volt output (1 major graticule division).

d. Set the (+) AC GND DC switch to DC and the VOLTS/DIV switch to .2 mVOLTS. Use the ATTEN BAL control to center the display. The display should consist of either one or two traces.

e. Adjust DIFF BAL R131 (R331) for maximum low-frequency cancellation as indicated by the elimination of the two-trace appearance so that only a single trace of minimum thickness remains. Disregard any pulses on the trace. If necessary, use the ATTEN BAL control as a position control to keep the display near the center of the crt.

13. Adjust Channel 1 Attenuator Dc Differential Balance R105F, R106F, and R107F

a. Set the VOLTS/DIV switch to 10 VOLTS and the (+) AC GND DC switch to GND.

b. Turn off the square-wave generator output and remove the termination. Reconnect the generator to both the (+) and the (—) input connectors.

c. Turn on the generator and set the output to 20 volts (2 major graticule divisions).

d. Set the (+) AC GND DC switch to DC and the VOLTS/DIV switch to 20 mVOLTS.

e. Adjust R105F (R305F) for maximum low-frequency cancellation resulting in one trace of minimum thickness. Disregard any differentiated pulses which may be on the trace.

f. Set the VOLTS/DIV switch to .2 VOLTS.

g. Set the generator output to about 100 volts. This is the maximum output of a Tektronix Type 105.

h. Adjust R106F (R306F) for maximum low-frequecy cancellation resulting in one trace of minimum thickness.

i. Set the VOLTS/DIV switch to 2 VOLTS and adjust R107F (R307F) for maximum low-frequency cancellation.

j. Turn off the generator output and set both AC GND DC switches to GND.

14. Adjust Channel 2 DIFF BAL R331

a. Set the MODE switch to CH 2 and repeat step 12.

15. Adjust Channel 2 Attenuator Dc Differential Balance R305F, R306F, and R307F

a. Repeat step 13.

b. Remove the signal connections from the Type 3A3.

16. Adjust Channel 2 Input Neutralization C316 and C416

a. Set the VOLTS/DIV switch to 10 mVOLTS and the (+) AC GND DC switch to DC.

b. Set the time-base controls for free-running sweeps at about 0.5 msec/div.

c. Terminate the square-wave generator output and connect it to the (+) input. If a Tektronix Type 105 is used, place one X10 coaxial attenuator between the generator output and the 50-ohm termination.

d. Set the generator frequency to 1 kc and output amplitude for 5 major divisions of deflection.

e. Obtain a triggered display.

f. Move the (—) AC GND DC switch back and forth between the GND and DC positions and adjust C316 (C116) so that the shape of the pulse display is most nearly the same for the two switch settings.

g. Set the (—) AC GND DC switch to DC and move the signal connection to the (—) input.

h. Move the (+) AC GND DC switch back and forth between the GND and DC positions and adjust C416 (C216) so that the shape of the pulse display is most nearly the same for the two switch settings.

i. Reset both AC GND DC switches to GND.

17. Adjust Channel 1 Input Neutralization C116 and C216

a. Set the MODE switch to CH 1 and repeat step 16.

18. Adjust Channel 1 X1 Attenuator Input Constant C109 and C209

a. Move the square-wave signal connection from the Type 3A3 to the Input Time Constant Standardizer; then connect the standardizer to the (+) input connector.

b. Set the (+) AC GND DC switch to DC and set the generator amplitude for about 5 major graticule divisions of deflection.

c. Obtain a triggered display.

d. Adjust C109 (C309) to make the top of the displayed square wave as straight and flat as possible.

e. Set the (+) AC GND DC switch to GND and move the signal connection to the (—) input.

f. Set the (—) AC GND DC switch to DC and adjust C209 (C409) to make the bottom of the displayed square wave as straight and flat as possible.

g. Reset the (—) AC GND DC switch to GND.

19. Adjust Channel 2 X1 Attenuator Input Time Constants C309 and C409

a. Set the MODE switch to CH 2 and repeat step 18.

b. Disconnect the input signal.

20. Adjust Channel 2 High-Frequency Differential Balance C314 and C315

a. Remove the time-base plug-in unit (not applicable to Tektronix Tye 565 and Type RM565 Oscilloscopes) and install any 2A- or 3A-Series plug-in unit in the right-hand compartment.

b. Connect the sine-wave generator output to both the (+) and the (—) input connectors of the Type 3A3 in the left-hand compartment.

c. Set the Type 3A3 VOLTS/DIV switch to 2 VOLTS and the (+) AC GND DC switch to DC.

d. Set the generator frequency to 100 kc and output amplitude to about 10 volts peak-to-peak (5 major graticule divisions of vertical deflection).

e. Make a single-ended connection between the sine-wave generator output and the input of the plug-in unit in the right-hand compartment. (If a Tektronix Type 565 or Type RM565 Oscilloscope is being used, make the connection to the appropriate EXT. HORIZ. IN connector.)

f. Set the right-hand unit VOLTS/DIV switch and VARIABLE control (EXT. HORIZ. GAIN for Type 565 and Type RM565) for about 10 major graticule divisions of horizontal deflection.

g. Set the Type 3A3 (—) AC GND DC switch to DC and VOLTS/DIV switch to 1 mVOLTS.

h. Note that by adjusting C314 (C114) the display can be made to appear as a circle, an elipse, or an essentially straight line. Set the capacitor to obtain the best straight-line appearance.

i. Note that by adjusting C315 (C115) the display can be made to pivot on its center with a resulting loss of the straight-line appearance. Set the capacitor so that the vertical positions of the right and left ends of the display are most nearly the same.

j. Repeat steps (h) and (i) until no further improvement can be made.

NOTE

A straight line which is perfectly parallel with the horizontal lines of the graticule and has no vertical amplitude whatsoever would indicate an infinite common-mode rejection ratio.

k. Set the Type 3A3 VOLTS/DIV switch to .1 mVOLTS.

l. Refine the adjustment of C314 (C114) and C315 (C115) to obtain a display which most nearly exhibits the characteristics described in the preceding NOTE. The probable result is a horizontal figure eight having a vertical amplitude of less than 2 major graticule divisions peak-to-peak. Make this figure eight as nearly symmetrical as possible.

NOTE

A final vertical peak-to-peak display amplitude of major graticule divisions with 10 volts peak-to-peak applied in common-mode would indicate a common-mode rejection ratio of 50,000:1 (10 volts divided by 200 μvolts = 50,000). This dynamic test can be used with other frequencies and common-mode amplitudes to evaluate performance with a particular set of circumstances.

m. Set the Type 3A3 VOLTS/DIV switch to .1 VOLTS and both AC GND DC switches to GND. Remove the signal connections.

21. Adjust Channel 1 High-Frequency Differential Balance C114 and C115

a. Set the MODE switch to CH 1 and repeat step 20.

b. Remove the signal connections and the right-hand plug-in unit. Reinstall the time-base plug-in unit in the right-hand compartment and restore the free-running sweeps at 0.1 msec/div.

22. Adjust Channel 1 Input Attenuator Compensation C105C, C106C, C107C, C205C, C206C, and C207C

a. Terminate the square-wave generator output and connect it to the (+) input.

b. Set the (+) AC GND DC switch to DC.

c. Set the generator frequency to 2.5 kc and the output amplitude for about 5 major graticule divisions of deflection.

d. Obtain a triggered display.

e. Adjust C105C (C305C) to make the top leading corner of the square-wave display as square as possible.

f. Set the VOLTS/DIV switch to 1 VOLTS and increase the generator output amplitude to obtain about 5 major divisions of deflection.

g. Adjust C106C (C306C) to make the top leading corner of the square-wave display as square as possible.

h. Set the VOLTS/DIV switch to 2 VOLTS and increase the generator output amplitude to obtain about 5 major divisions of deflection.

i. Adjust C107C (C307C) to make the top leading corner of the square-wave display as square as possible.

j. Set the VOLTS/DIV switch to 10 VOLTS.

k. Disconnect the square-wave generator and set the time-base controls for free-running sweeps.

l. Connect the sine-wave generator to both the (+) and the (—) input connectors.

m. Set the sine-wave generator frequency to 10 kc and the output amplitude to about 10 volts peak-to-peak.

n. Set the (—) AC GND DC switch to DC and the VOLTS/DIV switch to 20 mVOLTS.

o. Adjust C205C (C405C) for minimum display amplitude. Judge the correctness of the adjustment with the tool disengaged from the capacitor.

p. Set the VOLTS/DIV switch to .2 VOLTS and adjust C206C (C406C) for minimum display amplitude.

q. Set the VOLTS/DIV switch to 2 VOLTS and adjust C207C (C407C) for minimum display amplitude.

r. Reset both AC GND DC switches to GND and disconnect the input signal.

23. Adjust Channel 2 Input Attenuator Compensation C305C, C306C, C307C, C405C, C406C, and C407C

a. Set the MODE switch to CH 2 and repeat step 22.

24. Adjust Channel 2 Input Time Constant 305A, C306A, C307A, C405A, C406A, and C407A

a. Connect the Input Time Constant Standardizer to the (+) input.

b. Connect the terminated square-wave generator output to the standardizer input.

c. Set the (+) AC GND DC switch to DC and the VOLTS/DIV switch to .1 VOLTS.

d. Set the generator frequency to 1 kc and output amplitude for about 5 major graticule divisions of deflection.

e. Set the time-base controls for a 0.5 msec/div sweep rate and obtain a triggered display.

f. Adjust C305A (C105A) to make the top of the square-wave display as straight and flat as possible.

g. Set the VOLTS/DIV switch to 1 VOLTS and increase the generator amplitude for about 5 major divisions of deflection.

h. Adjust C306A (C106A) to make the top of the square-wave display as straight and flat as possible.

i. Set the VOLTS/DIV switch to 2 VOLTS and increase the generator amplitude for 3 to 5 major divisions of deflection.

j. Adjust C307A (C107A) to make the top of the square-wave display as straight and flat as possible.

k. Set the (+) AC GND DC switch to GND and the (—) AC GND DC switch to DC. Move the signal connection to the (—) input.

l. Adjust C407A (C207A) to make the bottom of the square-wave display as straight and flat as possible.

m. Set the VOLTS/DIV switch to 1 VOLTS and decrease the generator amplitude for about 5 major divisions of deflection.

n. Adjust C406A (C206A) to make the bottom of the square-wave display as straight and flat as possible.

o. Set the VOLTS/DIV switch to .1 VOLTS and decrease the generator amplitude for about 5 major divisions of deflection.

p. Adjust C405A (C205A) to make the bottom of the square-wave display as straght and flat as possible.

q. Set the (—) AC GND DC switch to GND and disconnect the input signal.

r. Set the time-base controls for free-running sweeps.

25. Adjust Channel 1 Input Time Constant C105A, C106A, C107A, C205A, C206A, and C207A

a. Set the MODE switch to CH 1 and repeat step 24.

26. Adjust Channel 1 High-Frequency Compensation C251B and C251M

a. Move the Type 3A3 to the right-hand compartment of the oscilloscope and do not use the plug-in unit extension. Install the time-base unit in the left-hand compartment (not applicable to Type 565 and Type RM565 Oscilloscopes).

b. Terminate the square-wave generator output and connect it to the Channel 1 (+) input. If a Tektronix Type 105 is used, place two X10 coaxial attenuators between the generator output and the 50-ohm termination. (See "Equipment Required", item 9.)

c. Set the VOLTS/DIV switch to 10 mVOLTS and the (+) AC GND DC switch to DC.

d. Set the generator frequency to 25 kc and output amplitude for about 8 major graticule divisions of horizontal deflection.

e. Set the time-base controls for triggered sweeps at a rate that will display about 4 cycles of the square-wave signal.

f. Adjust C251M (C451M) to make the lower right-hand corner of the square waves as square as possible.

g. Repeat step (f) for C251L (C451L) through C251B (C451B) using the information in Table 5-2. The adjustment sensitivity decreases with higher deflection sensitivities. It may be necessary to add a third X10 coaxial attenuator for the last one or two adjustments when a Tektronix Type 105 generator is used.

TABLE 5-2

VOLTS/DIV SWITCH	Adjust	
5 mVOLTS	C251L	(C451L)
2 mVOLTS	C251K	(C451K)
1 mVOLTS	C251H	(C451H)
.5 mVOLTS	C251F	(C451F)
.2 mVOLTS	C251D	(C451D)
.1 mVOLTS	C251B	(C451B)

h. Set the (+) AC GND DC switch to GND and set the time-base controls for free-running sweeps.

27. Adjust Channel 2 High-Frequency and Phase Compensation C451B and C451M

NOTE

There are two methods by which the Channel 2 high-frequency and phase-compensation capacitors may be adjusted. The choice of method depends upon whether you have more than one Type 3A3 and, if so, whether they will be used in the X-Y configuration for precise phase comparisons (not applicable to Type 565 and Type RM565 Oscilloscopes). When two Type 3A3 plug-in units have each had both channels adjusted according to step 26, there will generally be less than 2° phase difference between them at 100 kc. If this degree of accuracy is adequate or if you have but one Type 3A3, set the MODE switch to CH 2 and use step 26. Otherwise, the following general procedure is recommended:

a. Remove the Type 3A3 and tape a label marked "vertical" on the front panel. Set this unit aside and install a second calibrated Type 3A3 on a plug-in unit extension in the right-hand compartment of the oscilloscope. Mark this second unit "horizontal".

b. Adjust both internal GAIN controls of the horizontal unit for proper horizontal deflection sensitivity with the front-panel CALIBRATE control set to midrange. Then remove the extension and install the horizontal unit in the right-hand compartment.

c. Remove the time-base unit and install the vertical unit in the left-hand compartment without an extension. Set all four VOLTS/DIV switches to 10 mVOLTS.

d. Capacitors C251B through C251M in Channel 1 of the vertical unit were adjusted in step 26 for proper high-frequency response and will now provide the starting point for the phasing adjustments. Adjustment of the comparable capacitors in both channels of the horizontal unit and in Channel 2 of the vertical unit for proper phasing will also provide proper high-frequency response in these channels.

e. If future phase measurements will involve frequencies of 100 kc or below, use a 100-kc sine wave for the phasing adjustments. If the measurements will involve a frequency above 100 kc, but within the bandpass of the instrument, use that sine-wave frequency. Apply the signal to the Channel 1 (+) input of the vertical unit and to the (+) input of either channel of the horizontal unit.

f. Adjust the appropriate capacitor in the horizontal unit for each VOLTS/DIV switch setting; 10 mVOLTS through .1 mVOLTS to obtain proper phasing. Repeat for the other channel of the horizontal unit.

g. Transpose the units so that the vertical unit is in the horizontal compartment and the horizontal unit is in the vertical compartment. Do not recalibrate the internal GAIN controls or the front-panel CALIBRATE controls.

h. Adjust the capacitors in Channel 2 of the vertical unit against either channel in the other unit for proper phasing.

i. Calibration of the horizontal unit is now completed; remove and set it aside. The gain of this unit may be reset for proper vertical-deflection sensitivity whenever it is to be used in the coventional manner with a time-base unit. However, the gain should be set as described in step (b) when it is to be used with the vertical unit for X-Y displays.

j. Move the vertical unit to the left-hand compartment without an extension. Install a time-base unit in the right-hand compartment. Set the Type 3A3 MODE switch to CH 1 and proceed to step 28.

28. Check Channel 1 Risetime

a. Terminate the square-wave generator output and connect it to the (+) input. If a Tektronix Type 105 is used, place two X10 coaxial attenuators between the generator output and the 50-ohm termination.

b. Set the (+) AC GND DC switch to DC and the VOLTS/DIV switch to 10 mVOLTS.

c. Set the generator frequency to 100 kc and output amplitude for exactly 5 major graticule divisions of deflection.

d. Set the time-base controls for a 1 μsec/div sweep rate and a triggered display.

e. Check that the risetime between the 10% and 90% levels (one-half major division from top and bottom) is 0.7 μsec or less.

f. Reduce the generator frequency to 2.5 kc. Set the time-base controls for a 0.1 msec/div sweep rate.

g. Set the generator amplitude for exactly 5 major divisions of deflection.

h. Set the bandwidth switch to LO and check that the risetime between the 10% and 90% levels of the display is 70 μsec or less.

i. Reset the (+) AC GND DC switch to GND and the BANDWIDTH switch to HI.

j. Remove the signal connection.

29. Check Channel 2 Risetime

a. Set the MODE switch to CH 2 and repeat step 28.

30. Adjust Trigger Amplifier Dc Output Balance and Level R511, R525, R541, R555, and R565

a. Set the time-base controls for free-running sweeps at 0.5 msec/div.

b. Touch-up the adjustment of the RANGE and ATTEN BAL controls of both channels.

c. Connect X10 attenuator probes to each of the Channel 1 input connectors. Connect one probe to pin 3 and the other to pin 8 of the V583 tube socket.

d. Set the TRIGGER switch to CH 2, the MODE switch to CH 2, and the Channel 1 VOLTS/DIV switch to 50 mVOLTS.

e. Set the Channel 2 VOLTS/DIV switch to 10 mVOLTS and the POSITION control to center the trace.

f. Set the Channel 2 VOLTS/DIV switch to .1 mVOLTS and use the ATTEN BAL control to recenter the trace. Then set the Channel 2 VOLTS/DIV switch to 10 mVOLTS.

g. Set the MODE switch to CH 1 and use the Channel 1 POSITION control to center the trace.

h. Set both the Channel 1 AC GND DC switches to DC and adjust Channel 2 TRIG DC BALANCE R541 to recenter the trace.

i. Set one of the Channel 1 AC GND DC switches to GND and adjust Channel 2 TRIG DC LEVEL R555 to recenter the trace.

j. Set both Channel 1 AC GND DC switches to GND.

k. Leave the probe tips connected to the tube socket, but move them from Channel 1 to Channel 2.

l. Set the TRIGGER switch to CH 1, the Channel 2 VOLTS/DIV switch to 50 mVOLTS, and the Channel 1 VOLTS/DIV switch to 10 mVOLTS. Use the Channel 1 POSITION control to center the trace.

m. Set the Channel 1 VOLTS/DIV switch to .1 mVOLTS and use the Channel 1 ATTEN BAL control to recenter the trace. Then set the Channel 1 VOLTS/DIV switch to 10 mVOLTS.

n. Set the MODE switch to CH 2 and use the Channel 2 POSITION control to center the trace.

o. Set both of the Channel 2 AC GND DC switches to DC and adjust Channel 1 TRIG DC BALANCE R511 to recenter the trace.

p. Set one of the Channel 2 AC GND DC switches to GND and adjust Channel 1 TRIG DC LEVEL R525 to recenter the trace.

q. Set both Channel 2 AC GND DC switches to GND and remove the probes.

r. Connect a X10 probe to the test oscilloscope and adjust the probe compensation for proper response.

s. Connect the probe tip to pin 8 of the V583 tube socket.

t. Set the test-oscilloscope input coupling switch to AC or GND and position its trace to the center of the graticule.

u. Set the Type 3A3 TRIGGER switch to COMP and use the Channel 2 POSITION control to center the trace.

v. Set the test-oscilloscope input coupling switch to DC and an input sensitivity of 0.2 volts/div (excluding the probe).

w. Adjust COMP TRIG DC LEVEL R565 to center the trace on the test oscilloscope. Retain this setup for the next step.

31. Adjust Trigger Amplifier High-Frequency Compensation C508, C518, C538, C548, C561, and C569

a. Set both of the Type 3A3 VOLTS/DIV switches to .2 VOLTS.

b. Connect the terminated output of the square-wave generator to the Channel 2 (+) input connector.

c. Set the (+) AC GND DC switch to DC.

d. Set the generator frequency to 2.5 kc and output amplitude for about 5 major divisions deflection on the oscilloscope containing the Type 3A3.

e. Obtain a triggered display of the square-wave signal on the test oscilloscope.

f. Adjust C569 for best square-wave response as indicated on the test oscilloscope.

g. Set the TRIGGER switch to CH 2 and adjust C548 for best square-wave response as indicated on the test oscilloscope.

h. Move the signal input connection to the Channel 1 (+) connector.

i. Set the Channel 1 (+) AC GND DC switch to DC, the TRIGGER switch to CH 1 and the MODE switch to CH 1.

j. Adjust C518 for best square-wave response as indicated on the test oscilloscope.

k. Move the probe from pin 8 to pin 3 of the V583 tube socket.

l. Adjust C508 for best square-wave response.

m. Set the TRIGGER switch to COMP and adjust C561 for best square-wave response.

n. Move the signal input connection to the Channel 2 (+) connector and set the TRIGGER switch to CH 2.

o. Adjust C538 for best square-wave response.

p. Remove all connections from the Type 3A3.

32. Check Alternate-Trace Mode

a. Set the MODE switch to ALTER and the time-base controls for free-running sweeps at 50 msec/div.

b. Check that the Channel 1 and Channel 2 traces appear alternately on the crt.

33. Check Chopped-Trace Mode

a. Set the MODE switch to CHOP and the TRIGGER switch to COMP.

b. Check for two traces on the crt.

34. Check Chopped-Trace Blanking

a. Set the CRT CATHODE SELECTOR switch on the oscilloscope rear panel (not applicable to Type 565 and Type RM565 Oscilloscopes) to the CATHODE BLANKING position.

b. Set the POSITION controls so that there is about 4 major divisions separation between the two traces.

c. Set the time-base controls for internally triggered sweeps at 2 μsec/div.

d. You should obtain what appears to be a square-wave display. However, the rising and falling portions of the display should not be visible except when the intensity of the top and bottom portions is unnecessarily high.

35. Check Dual-Trace X-Y Operation (Optional)

NOTE

This step can be performed only if you have more than one Type 3A3 and an oscilloscope other than the Type 565 or Type RM565.

a. Install a second Type 3A3 in place of the time-base unit in the right-hand compartment of the oscilloscope. Allow several minutes for warmup.

b. Set all eight AC GND DC switches to GND and all four VOLTS/DIV switches to 10 mVOLTS.

c. Set the MODE switch of one unit to CHOP and the MODE switch of the other unit to ALTER.

d. Check that two spots can be obtained on the crt. Check that each of the four POSITION controls affects only one spot.

NOTES

SECTION 6

PARTS LIST AND DIAGRAMS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix Field Office.

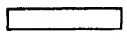
Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix Field Office will contact you concerning any change in part number.

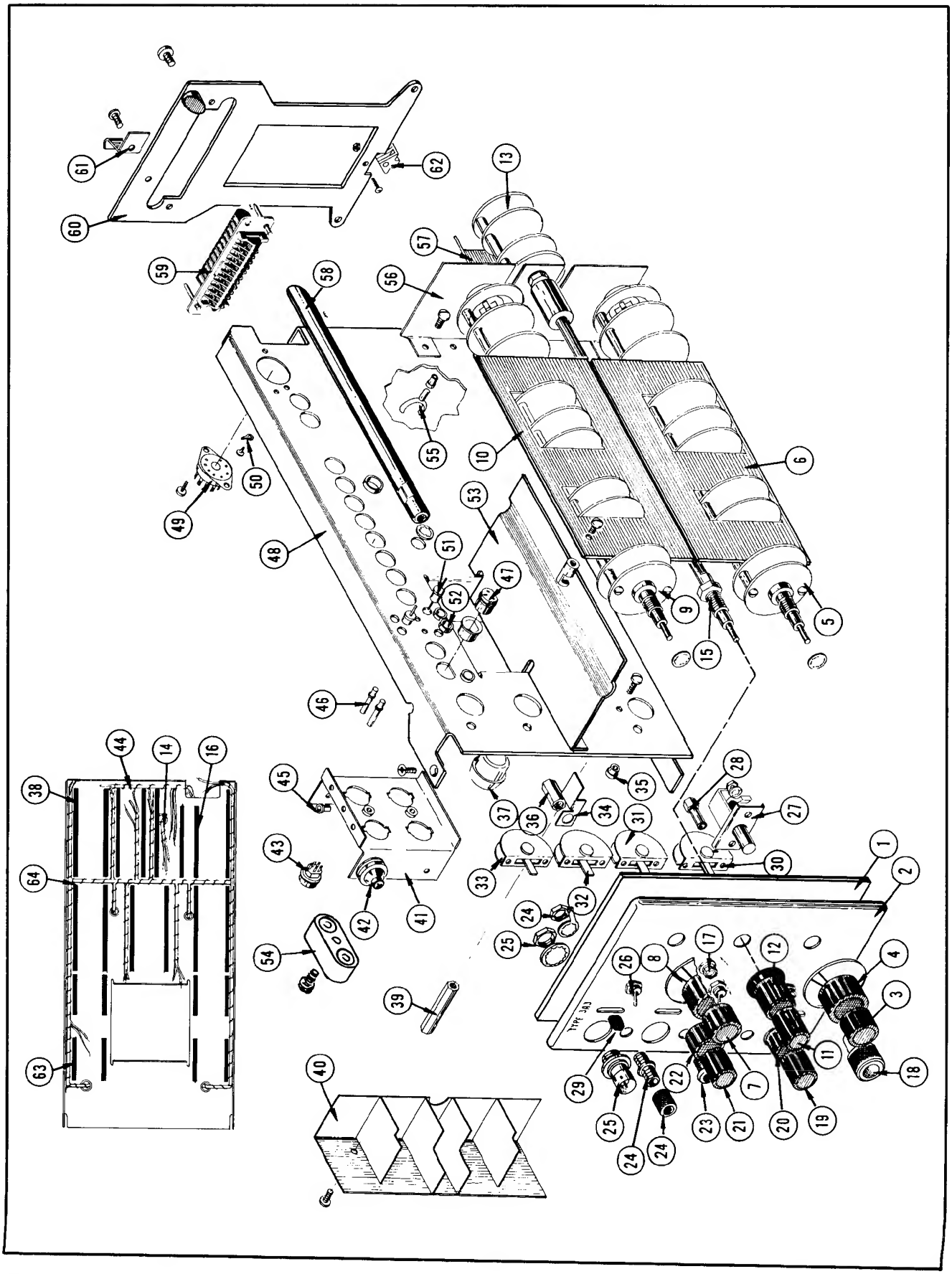
ABBREVIATIONS AND SYMBOLS

a or amp	amperes
BHS	binding head steel
C	carbon
cer	ceramic
cm	centimeter
comp	composition
cps	cycles per second
crt	cathode-ray tube
CSK	counter sunk
dia	diameter
div	division
EMC	electrolytic, metal cased
EMT	electroyltic, metal tubular
ext	external
f	farad
F & I	focus and intensity
FHS	flat head steel
Fil HS	fillister head steel
g or G	giga, or 10^9
Ge	germanium
GMV	guaranteed minimum value
h	henry
hex	hexagonal
HHS	hex head steel
HSS	hex socket steel
HV	high voltage
ID	inside diameter
incd	incandescent
int	internal
k or K	kilohms or kilo (10^3)
kc	kilocycle
m	milli, or 10^{-3}
mc	megacycle
mm	millimeter
meg or M	megohms or mega (10^6)
met.	metal
μ	micro, or 10^{-6}
n	nano, or 10^{-9}
Ω	ohm
OD	outside diameter
OHS	oval head steel
p	pico, or 10^{-12}
PHS	pan head steel
piv	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
Prec	precision
PT	paper tubular
PTM	paper or plastic, tubular, molded
RHS	round head steel
rms	root mean square
sec	second
Si	silicon
S/N	serial number
t or T	tera, or 10^{12}
TD	toroid
THS	truss head steel
tub.	tubular
v or V	volt
Var	variable
w	watt
w/	with
w/o	without
WW	wire-wound

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number.
000X	Part removed after this serial number.
*000-000	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

EXPLODED VIEW



EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	387-0876-00			1	PLATE, subpanel, front
2	333-0788-00			1	PANEL, front
3	366-0081-00			1	KNOB, VARIABLE, red
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
4	366-0230-00			1	KNOB, VOLTS/DIV, charcoal
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
5	262-0627-00	100	1129	1	SWITCH, VOLTS/DIV, Ch 2, wired
	262-0627-01	1130		1	SWITCH, VOLTS/DIV, Ch 2, wired
	- - - - - -			-	Includes:
	260-0590-00			1	SWITCH, VOLTS/DIV, Ch 2, unwired
	352-0071-00			6	HOLDER, PC BOARD, nylon
	166-0025-00			2	TUBE, spacer alum. 3/16 OD x 1/4 inch long
	211-0014-00			2	SCREW, 4-40 x 1/2 inch BHS
	- - - - - -			-	Mounting Hardware for Switch:
	210-0413-00			1	NUT, hex, brass, 3/8-32 x 1/2 inch
	210-0012-00			1	LOCKWASHER, steel pot, internal 3/8 x 1/2 inch
	210-0840-00			1	WASHER, steel .390 ID x 9/16 inch OD
6	670-0059-00			1	ASSEMBLY, circuit board, charcoal 2 (wired)
	- - - - - -			-	assembly includes:
	388-0572-00	100	139	1	BOARD, etched circuit (unwired)
	388-0603-00	140		1	BOARD, etched circuit (unwired)
	- - - - - -			-	board includes:
	131-0285-00			4	CONNECTOR, terminal
	- - - - - -			-	mounting hardware: (not incl w/assembly)
	211-0008-00			6	SCREW, 4-40 x 1/4 inch BHS
7	366-0081-00			1	KNOB, VARIABLE, red
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
8	366-0230-00			1	KNOB, VOLTS/DIV, charcoal
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
9	262-0623-00	100	1129	1	SWITCH, VOLTS/DIV, Ch 1, wired
	262-0623-01	1130		1	SWITCH, VOLTS/DIV, Ch 1, wired
	- - - - - -			-	Includes:
	260-0590-00			1	SWITCH, VOLTS/DIV, Ch 1, unwired
	352-0071-00			6	HOLDER, PC BOARD, nylon
	166-0025-00			2	TUBE, spacer alum. 3/16 OD x 1/4 inch long
	211-0014-00			2	SCREW, 4-40 x 1/2 inch BHS
	- - - - - -			-	Mounting Hardware for Switch:
	210-0413-00			1	NUT, hex, brass, 3/8-32 x 1/2 inch
	210-0012-00			1	LOCKWASHER, steel pot, internal 3/8 x 1/2 inch
	210-0840-00			1	WASHER, steel .390 ID x 9/16 inch OD
10	670-0046-00			1	ASSEMBLY, circuit board, channel 1 (wired)
	- - - - - -			-	assembly includes:
	388-0572-00			1	BOARD, etched circuit (unwired)
	- - - - - -			-	board includes:
	131-0285-00			4	CONNECTOR, terminal
	- - - - - -			-	mounting hardware: (not incl w/assembly)
	211-0008-00			6	SCREW, 4-40 x 1/4 inch BHS

EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
11	366-0189-00			1	KNOB, TRIGGER, red
	- - - - - -			-	Includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch HSS
12	366-0175-00			1	KNOB, MODE, charcoal
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
13	262-0624-00			1	SWITCH, MODE TRIGGER, wired
	- - - - - -			-	Includes:
	260-0589-00			1	SWITCH, MODE TRIGGER, unwired
	- - - - - -			-	Mounting Hardware for Switch:
	210-0413-00			3	NUT, hex, brass, 3/8-32 x 1/2 inch
14	179-0888-00			1	CABLE, Harness Mode Switch
15	358-0029-00			1	BUSHING, brass, hex, 3/8-32 x 13/32 inch
16	124-0146-00			2	STRIP, Ceramic 16 Notches 2 7/16 x 7/16 inch
	- - - - - -			-	Includes:
	355-0046-00			2	STUD, nylon, short
	- - - - - -			-	Mounting Hardware for Strip:
	361-0009-00			2	SPACER, nylon, 3/8 inch high
17	- - - - - -			-	POT, Mounting Hardware
	210-0467-00			1	NUT, hex, 12-28 x 5/16 inch
	210-0971-00			1	WASHER, flat steel
18	366-0109-00			1	KNOB, Plug-In Securing 9/16 inch alum. x 5/8 inch
	- - - - - -			-	Includes:
	213-0006-00			1	SCREW, set, 8-32 x 3/16 inch HSS
19	366-0265-00			1	KNOB, POSITION, red
	- - - - - -			-	Includes:
	213-0022-00			1	SCREW, set, 4-40 x 3/16 inch HSS
20	366-0264-00			1	KNOB, ATTEN BAL, charcoal
	- - - - - -			-	Includes:
	213-0022-00			1	SCREW, set, 4-40 x 3/16 inch HSS
21	366-0265-00			1	KNOB, POSITION, red
	- - - - - -			-	Includes:
	213-0022-00			1	SCREW, set, 4-40 x 3/16 inch HSS
22	366-0264-00			1	KNOB, ATTEN BAL, charcoal
	- - - - - -			-	Includes:
	213-0022-00			1	SCREW, set, 4-40 x 3/16 inch HSS
23	358-0054-00			1	BUSHING, Banana Jack, brass 1/4-32 x 13/32 inch
24	129-0053-00			2	POST, Binding BPN13
	- - - - - -			-	Includes:
	200-0103-00			1	CAP, Binding Post Adapter
	355-0507-00			1	STEM, Binding Post Adapter
	- - - - - -			-	Mounting Hardware for each (not included w/post)
	210-0455-00			1	NUT, hex, steel 1/4-28 x 3/8 x 3/32 inch
	210-0223-00			1	LUG, Solder, 1/4 inch Hole
25	131-0274-00			4	CONNECTOR, Chassis Mounting BNC insulated

EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
26	260-0407-00			3	SWITCH, Toggle SPDT 2 pos. min.
	- - - - - -			-	Includes:
	210-0562-00			1	NUT, hex, brass, 1/4-40 x 5/16 inch
	210-0046-00			1	LOCKWASHER, steel shakeproof
	- - - - - -			-	WASHER, flat (not supplied by Tektronix)
27	214-0052-00			1	FASTENER, Right w/Stop
	- - - - - -			-	Mounting Hardware for Fastener:
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 inch
28	220-0413-00			8	NUT, Switch Mounting 3/16 inch hex brass rod
29	366-0215-00	100	969	4	KNOB, Lever, charcoal
	366-0215-00	970		4	KNOB, Lever, charcoal
30	260-0600-00			1	SWITCH, AC DC, Ch 2
31	260-0600-00			1	SWITCH, AC DC, Ch 2
32	260-0600-00			1	SWITCH, AC DC, Ch 1
33	260-0600-00			1	SWITCH, AC DC, Ch 1
34	337-0613-00			1	SHIELD, Cross Talk, alum.
35	348-0031-00			18	GROMMET, Polypropylene, Snap-In 1/4 inch dia.
36	210-0471-00			1	NUT, Pot Miniature, hex alum. 1/4-32 x 5/16 inch dia.
37	354-0068-00			4	RING, Securing, Polyethylene
38	124-0145-00			12	STRIP, Ceramic 20 Notches x 7/16 inch
	- - - - - -			-	Includes:
	355-0046-00			2	STUD, nylon, short
	- - - - - -			-	Mounting Hardware for Strip:
	361-0009-00			2	SPACER, nylon, 3/8 inch high
39	361-0068-00			2	SPACER, Shield 1/4 inch hex alum. rod
40	337-0612-00			1	SHIELD, Input, alum.
	- - - - - -			-	Mounting Hardware for Shield:
	211-0504-00	100	1569	2	SCREW, 6-32 x 1/4 inch BHS
	211-0542-00	1570		2	SCREW, 6-32 x 5/16 inch, THS
41	441-0535-00			1	CHASSIS, Preamp. alum.
	- - - - - -			-	Mounting Hardware for Chassis:
	210-0406-00			4	NUT, hex, brass, 4-40 x 3/16 inch
42	348-0058-00			4	SHOCKMOUNT, Rubber
43	136-0131-00			1	SOCKET, 5 pin Solder Mount
44	179-0881-00	100	1129	1	CABLE, Harness Amph.
	179-0881-01	1130		1	CABLE, Harness, Amph.
45	348-0031-00			6	GROMMET, Polyproyplene, Snap-In 1/4 inch dia.

EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
46	426-0225-00			4	MOUNT, Capacitor Molded Polypropylene
47	136-0181-00			37	SOCKET, Transistor 3 Pin
	- - - - - -			-	Mounting Hardware for Socket:
	354-0234-00			1	RING, insulator 3/8 inch diameter teflon rod
48	441-0536-00			1	CHASSIS, 3A3, alum.
	- - - - - -			-	Mounting Hardware for Chassis:
	211-0541-00			2	SCREW, 6-32 x 1/4 inch FHS, 100° CSK, phillips
	211-0507-00			3	SCREW, 6-32 x 5/16 inch BHS
49	136-0072-00			2	SOCKET, 9 pin UHF Miniature
	- - - - - -			-	Mounting Hardware for Socket:
	213-0044-00			2	SCREW, Thread Cutting, 5-32 x 3/16 inch Pan H
50	210-0259-00			20	LUG, soder #2 internal
	- - - - - -			-	Mounting Hardware for Lug:
	213-0055-00			1	SCREW, Thread Cutting, 2-56 x 3/16 inch PHS
51	131-0157-00			8	CONNECTOR, Terminal, Teflon, Stand Off
52	348-0055-00			4	GROMMET, Plastic 1/4 inch diameter mounting hole, delrin
53	337-0610-00			1	SHIELD, Electron Static, alum
	- - - - - -			-	Mounting Hardware for Shield:
	210-0457-00			2	NUT, Keps, steel, 6-32 x 5/16 inch
54	200-0554-00			2	COVER, Heat Stabilizer
	377-0103-00			4	INSERT, Heat Stabilizer
55	426-0121-00			1	MOUNT, Toroid, nylon, 15/32 x 1/8 x 9/64 inch
	- - - - - -			-	Mounting Hardware for Mount:
	361-0007-00			1	SPACER, nylon, molded
56	406-0967-00			1	BRACKET, Switch, alum.
	- - - - - -			-	Mounting Hardware for Bracket:
	211-0029-00			4	SCREW, 5-40 x 3/16 inch Pan HS
	211-0507-00			3	SCREW, 6-32 x 5/16 inch BHS
57	337-0611-00			1	SHIELD, MODE, Switch, alum.
58	384-0615-00			4	ROD, Spacer Plug-In hex tubing 12 1/4 inches long
	- - - - - -			-	Mounting Hardware for Rod:
	212-0044-00			4	SCREW, 8-32 x 1/2 inch RHS Phillips
59	131-0149-00			1	CONNECTOR, Chassis Mount 24 Contact, male
	- - - - - -			-	Mounting Hardware for Connector:
	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS
	210-0004-00			2	LOCKWASHER, steel, internal #4
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 inch
60	387-0647-00			1	PLATE, Rear Panel, alum.
61	214-0276-00			2	SPRING, Ground 29/64 x 1/2 x 1 1/16 inch
	- - - - - -			-	Mounting Hardware for Spring:
	211-0507-00			1	SCREW, 6-32 x 5/16 inch BHS
	210-0006-00			1	LOCKWASHER, steel, internal #6
	210-0407-00			1	NUT, hex, brass, 6-32 x 1/4 inch

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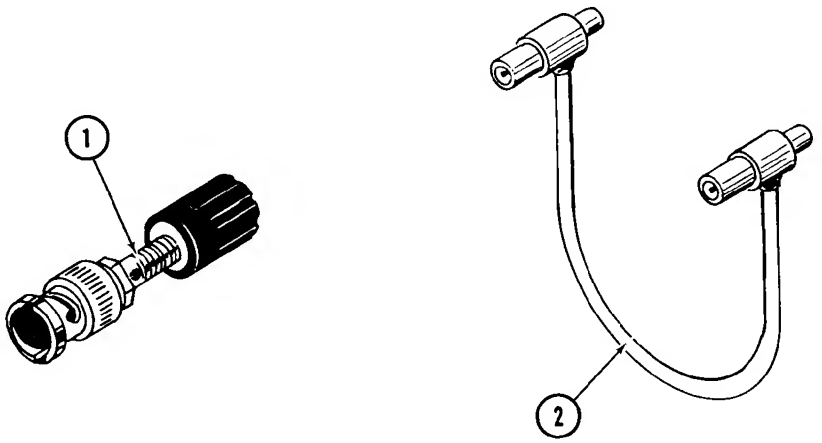
EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
62	351-0037-00			1	GUIDE, Plug-In, delrin, $\frac{5}{8}$ x $\frac{13}{16}$ inch
	- - - - - -			-	Mounting Hardware for Guide:
	211-0013-00			1	SCREW, 4-40 x $\frac{3}{8}$ inch RHS
	210-0406-00			1	NUT, hex, brass, 4-40 x $\frac{3}{16}$ inch
63	124-0148-00			8	STRIP, Ceramic 9 Natches $1\frac{7}{16}$ x $\frac{7}{16}$ inch
	- - - - - -			-	Includes:
	355-0046-00			2	STUD, nylon, short
	- - - - - -			-	Mounting Hardware for Strip:
	361-0009-00			2	SPACER, nylon, $\frac{3}{8}$ inch high
64	179-0853-00	100	1129	1	CABLE, harness, chassis
	179-0853-01	1130		1	CABLE, harness, chassis

©

ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	103-0033-00			4	ADAPTER, BNC to binding post
2	012-0087-00	X568		2	CORD, patch, BNC to BNC, 18 inch red
	070-0408-00			2	MANUAL, instruction (not shown)

©

ELECTRICAL PARTS

Values are fixed unless marked Variable.

Capacitors

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors as follows (with exceptions):

3V — 50V = —10%, +250%
51V — 350V = —10%, +100%
351V — 450V = —10%, +50%

Ckt. No.	Tektronix Part No.	Description				S/N Range
C101†	Use *295-081	0.1 μf	MT	600 v	10%	
C102	281-0504-00	10 pf	Cer	500 v	10%	X930-up
C105A	281-092	9-35 pf	Cer Var			100-1209
C105A	281-0093-00	5.5-18 pf	Cer Var			1210-up
C105C	281-091	2-8 pf	Cer Var			
C105E	283-601	22 pf	Mica	300 v	10%	
C106A	281-092	9-35 pf	Cer Var			100-1209
C106A	281-0093-00	5.5-18 pf	Cer Var			1210-up
C106C	281-091	2-8 pf	Cer Var			
C106E	283-597	470 pf	Mica	300 v	10%	
C107A	281-092	9-35 pf	Cer Var			100-1209
C107A	281-0093-00	5.5-18 pf	Cer Var			1210-up
C107C	281-091	2-8 pf	Cer Var			
C107E	283-100	0.0047 μf	Cer	200 v	10%	
C109	281-093	5.5-18 pf	Cer Var			
C114	281-060	2-8 pf	Cer Var			
C115	281-060	2-8 pf	Cer Var			
C116	281-053	0.35-1.37 pf	Var			
C117	290-0285-00	4 μf	EMT	200 v	+50%-10%	X1130-up
C124	283-065	0.001 μf	Cer	100 v	5%	
C128	283-004	0.02 μf	Cer	150 v		X550-up
C151	290-210	70 μf	EMT	15 v		
C181	Use 285-0622-00	0.1 μf	PTM	100 V		100-1129
C181	283-0079-00	0.01 μf	Cer	250 v		1130-up
C187	283-057	0.1 μf	Cer	200 v		X491-up
C201†	Use *295-081	0.1 μf	MT	600 v	10%	
C202	Use 281-0504-00	10 pf	Cer	500 v	10%	X930-up
C205A	281-092	9-35 pf	Cer Var			100-1209
C205A	281-0093-00	5.5-18 pf	Cer Var			1210-up
C205C	281-091	2-8 pf	Cer Var			
C205E	283-601	22 pf	Mica	300 v	10%	
C206A	281-092	9-35 pf	Cer Var			100-1209
C206A	281-0093-00	5.5-18 pf	Cer Var			1210-up
C206C	281-091	2-8 pf	Cer Var			
C206E	283-597	470 pf	Mica	300 v	10%	
C207A	281-092	9-35 pf	Cer Var			100-1209
C207A	281-0093-00	5.5-18 pf	Cer Var			1210-up
C207C	281-091	2-8 pf	Cer Var			
C207E	283-100	0.0047 μf	Cer	200 v	10%	
C209	281-093	5.5-18 pf	Cer Var			
C214	281-618	4.7 pf	Cer	200 v		
C215	281-618	4.7 pf	Cer	200 v		

†C101 and C201 matched within ±1% of each other, furnished as a unit.

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C216	281-053	0.35-1.37 pf		Var			
C251A	283-605	678 pf	Mica		300 v	1%	
C251B	281-092	9-35 pf	Cer	Var			
C251C	283-604	304 pf	Mica		300 v	2%	
C251D	281-092	9-35 pf	Cer	Var			
C251E	283-603	113 pf	Mica		300 v	2%	
C251F	281-093	5.5-18 pf	Cer	Var			
C251G	283-602	53 pf	Mica		300 v	5%	
C251H	Use 281-0093-00	5.5-18 pf	Cer	Var			
C251J	283-601	22 pf	Mica		300 v	10%	
C251K	281-091	2-8 pf	Cer	Var			
C251L	281-091	2-8 pf	Cer	Var			
C251M	281-064	0.2-1.5 pf	Tub.	Var			
C260	281-620	21 pf	Cer		500 v	1%	
C261	285-626	0.0015 μf	PTM		100 v	10%	100-1169
	283-0088-00	1100 pf	Cer		500 v	5%	1170-up
C281	Use 285-0622-00	0.1 μf	PTM		100 v		100-1129
C281	Use 283-0079-00	0.01 μf	Cer		250 v		1130-up
C301†	Use *295-081	0.1 μf	MT		600 v	10%	
C305A	281-092	9-35 pf	Cer	Var			100-1209
C305A	281-0093-00	5.5-18 pf	Cer	Var			1210-up
C305C	281-091	2-8 pf	Cer	Var			
C305E	283-601	22 pf	Mica		300 v	10%	
C302	281-0504-00	10 pf	Cer		500 v	10%	X930-up
C306A	281-092	9-35 pf	Cer	Var			100-1209
C306A	281-0093-00	5.5-18 pf	Cer	Var			1210-up
C306C	281-091	2-8 pf	Cer	Var			
C306E	283-597	470 pf	Mica		300 v	10%	
C307A	281-092	9-35 pf	Cer	Var			100-1209
C307A	281-0093-00	5.5-18 pf	Cer	Var			1210-up
C307C	281-091	2-8 pf	Cer	Var			
C307E	283-100	0.0047 μf	Cer		200 v	10%	
C309	281-093	5.5-18 pf	Cer	Var			
C314	281-060	2-8 pf	Cer	Var			
C315	281-060	2-8 pf	Cer	Var			
C316	281-053	0.35-1.37 pf		Var			
C324	283-065	0.001 μf	Cer		100 v	5%	
C351	290-210	70 μf	EMT		15 v		
C381	Use 285-0622-00	0.1 μf	PTM		100 v		100-1129
C381	283-0079-00	0.01 μf	Cer		250 v		1130-up
C387	283-057	0.1 μf	Cer		200 v		X491-up
C401†	Use *295-081	0.1 μf	MT		600 v	10%	
C402	281-0504-00	10 pf	Cer		500 v	10%	X930-up
C405A	281-092	9-35 pf	Cer	Var			100-1209
C405A	281-0093-00	5.5-18 pf	Cer	Var			1210-up
C405C	281-091	2-8 pf	Cer	Var			
C405E	283-601	22 pf	Mica		300 v	10%	
C406A	281-092	9-35 pf	Cer	Var			100-1209
C406A	281-0093-00	5.5-18 pf	Cer	Var			1210-up
C406C	281-091	2-8 pf	Cer	Var			
C406E	283-597	470 pf	Mica		300 v	10%	
C407A	281-092	9-35 pf	Cer	Var			100-1209
C407A	281-0093-00	5.5-18 pf	Cer	Var			1210-up

† C301 & C401 matched within ±1% of each other furnished as a unit.

©

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C407C	281-091	2-8 pf	Cer	Var			
C407E	283-100	0.0047 μf	Cer		200 v	10%	
C409	281-093	5.5-18 pf	Cer	Var			
C414	281-618	4.7 pf	Cer		200 v		
C415	281-618	4.7 pf	Cer		200 v		
C416	281-053	0.35-1.37 pf		Var			
C451A	283-605	678 pf	Mica		300 v	1%	
C451B	281-092	9-35 pf	Cer	Var			
C451C	283-604	304 pf	Mica		300 v	2%	
C451D	281-092	9-35 pf	Cer	Var			
C451E	283-603	113 pf	Mica		300 v	2%	
C451F	281-093	5.5-18 pf	Cer	Var			
C451G	283-602	53 pf	Mica		300 v	5%	
C451H	Use 281-0093-00	5.5-18 pf	Cer	Var			
C451J	283-601	22 pf	Mica		300 v	10%	
C451K	281-091	2-8 pf	Cer	Var			
C451L	281-091	2-8 pf	Cer	Var			
C451M	281-064	0.2-1.5 pf	Tub.	Var			
C460	281-620	21 pf	Cer		500 v	1%	
C461	285-626	0.0015 μf	PTM		100 v	10%	100-1169
C461	283-0088-00	1100 pf	Cer		500 v	5%	1170-up
C481	Use 285-0622-00	0.1 μf	PTM		100 v		100-1129
C481	283-0079-00	0.01 μf	Cer		250 v		1130-up
C508	281-094	5.5-18 pf	Cer	Var			
C509	283-601	22 pf	Mica		300 v	10%	
C518	281-094	5.5-18 pf	Cer	Var			
C519	283-601	22 pf	Mica		300 v	10%	
C538	281-094	5.5-18 pf	Cer	Var			
C539	283-601	22 pf	Mica		300 v	10%	
C548	281-094	5.5-18 pf	Cer	Var			
C549	283-601	22 pf	Mica		300 v	10%	
C561	281-094	5.5-18 pf	Cer	Var			
C562	281-504	10 pf	Cer		500 v	10%	
C568	281-504	10 pf	Cer		500 v	10%	
C569	281-094	5.5-18 pf	Cer	Var			
C604	281-552	25 pf	Cer		500 v		
C614	281-552	25 pf	Cer		500 v		
C619	281-540	51 pf	Cer			5%	
C621	281-552	25 pf	Cer		500 v		
C631	281-504	10 pf	Cer		500 v	10%	100-156
C631	281-510	22 pf	Cer		500 v		157-up
C633	281-516	39 pf	Cer		500 v	10%	100-156
C633	281-513	27 pf	Cer		500 v		157-up
C638	Use 281-518	47 pf	Cer		500 v		
C660	281-529	1.5 pf	Cer		500 v	±0.25 pf	
C661	Use *050-0298-00	Replacement Kit					100-759
C661	285-0651-01	0.0017 μf	PTM		100 v	5%	760-up
C671	Use 050-0298-00	Replacement Kit					100-759
C671	285-0651-01	0.0017 μf	PTM		100 v	5%	760-up
C683	290-0285-00	4 μf	EMT		200 v	+50%-10%	X1130-up
C687	283-057	0..1 μf	Cer		200 v		
C695	283-0059-00	1 μf	Cer		25 v	+80%-20%	X1130-up

Diodes

Ckt. No.	Tektronix Part No.	Description	S/N Range
D113	*152-165	Silicon Selected from 1N3579	
D213	*152-165	Silicon Selected from 1N3579	
D313	*152-165	Silicon Selected from 1N3579	
D413	*152-165	Silicon Selected from 1N3579	
D604	152-141	Silicon 1N3605	
D614	152-141	Silicon 1N3605	
D622	152-141	Silicon 1N3605	
D625	152-141	Silicon 1N3605	
D630	152-141	Silicon 1N3605	X157-up
D632	152-141	Silicon 1N3605	
D635	152-141	Silicon 1N3605	
D641	152-141	Silicon 1N3605	
D642	152-141	Silicon 1N3605	
D643	152-141	Silicon 1N3605	
D644	152-141	Silicon 1N3605	
D645	152-141	Silicon 1N3605	
D646	152-141	Silicon 1N3605	
D651	152-141	Silicon 1N3605	
D652	152-141	Silicon 1N3605	
D653	152-141	Silicon 1N3605	
D654	152-141	Silicon 1N3605	
D655	152-141	Silicon 1N3605	
D656	152-141	Silicon 1N3605	
D687	152-149	Zener 1N961B	
D688	152-141	Silicon 1N3605	
D689	152-141	Silicon 1N3605	
D692	152-148	Zener 1N3998A	
D699	152-150	Zener 1N3037B	

Inductors

L143	276-0532-00	Core, Shield Bead	X970-up
L174	276-0541-00	Suppressor, Ferrite	X590-up
L243	276-0532-00	Core, Shield Bead	X970-up
L261	*108-287	Reed Drive	
L274	276-0541-00	Suppressor, Ferrite	X590-up
L343	276-0532-00	Core, Shield Bead	X970-up
L374	276-0541-00	Suppressor, Ferrite	X590-up
L443	276-0532-00	Core, Shield Bead	X970-up
L461	*108-287	Reed Drive	
L474	276-0541-00	Suppressor, Ferrite	X590-up
L570	276-532	Core, Shield Bead	
L571	276-532	Core, Shield Bead	
L631	*120-183	Toroid, 9T	100-156
L631	*120-312	Toroid, 15T	157-up
L648	*108-237	80 μh	
L658	*108-237	80 μh	
L695	*120-0202-00	Toroid, 15T	X1130-up

Transistors

Q114†	Use *153-0534-00	Checked 2N2219
Q118	*151-133	Selected from 2N3251
Q128	*151-103	Replaceable by 2N2219
Q143	*151-103	Replaceable by 2N2219

†Q114 and Q214 furnished as a unit.

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q154	*151-133	Selected from 2N3251	
Q163	*151-133	Selected from 2N3251	
Q174	151-100	2N2191	100-589
Q174	*151-133	Selected from 2N3251	590-up
Q214†	Use *153-0534-00	Checked 2N2219	
Q243	*151-103	Replaceable by 2N2219	
Q254	*151-133	Selected from 2N3251	
Q263	*151-133	Selected from 2N3251	
Q274	151-100	2N2191	100-589
Q274	*151-133	Selected from 2N3251	590-up
Q314††	Use *153-0534-00	Checked 2N2219	
Q318	*151-133	Selected from 2N3251	
Q328	*151-103	Replaceable by 2N2219	
Q343	*151-103	Replaceable by 2N2219	
Q354	*151-133	Selected from 2N3251	
Q363	151-133	Selected from 2N3251	
Q374	151-100	2N2191	100-589
Q374	*151-133	Selected from 2N3251	590-up
Q414††	Use *153-0534-00	Checked 2N2219	
Q443	*151-103	Replaceable by 2N2219	
Q454	*151-133	Selected from 2N3251	
Q463	*151-133	Selected from 2N3251	
Q474	151-100	2N2191	100-589
Q474	*151-133	Selected from 2N3251	590-up
Q504	151-100	2N2191	100-589
Q504	*151-133	Selected from 2N3251	590-up
Q514	151-100	2N2191	100-589
Q514	*151-133	Selected from 2N3251	590-up
Q534	151-100	2N2191	100-589
Q534	*151-133	Selected from 2N3251	590-up
Q544	151-100	2N2191	100-589
Q544	*151-133	Selected from 2N3251	590-up
Q605	*151-133	Selected from 2N3251	
Q615	*151-133	Selected from 2N3251	
Q625	*151-103	Replaceable by 2N2219	
Q635	*151-103	Replaceable by 2N2219	
Q644	Use *151-133	Selected from 2N3251	
Q654	Use *151-133	Selected from 2N3251	
Q664	*151-103	Replaceable by 2N2219	
Q674	*151-103	Replaceable by 2N2219	
Q684	*151-103	Replaceable by 2N2219	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R101	315-105	1 meg	1/4 w		5%	
R102	315-101	100 Ω	1/4 w		5%	
R105C	323-611	900 k	1/2 w	Prec	1%	
R105E	Use 321-640	106 k	1/8 w	Prec	1%	
R105F	311-438	10 k		Var	CH 1 X10 ATTEN DC DIFF BAL	

†Q214 and Q114 furnished as a unit.

††Q314 and Q414 furnished as a unit.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R106C	323-614	990 k	½ w		Prec	1%	
R106E	Use 321-639	9.6 k	⅛ w		Prec	1%	
R106F	Use 311-393	1 k		Var		CH 1 X100 ATTEN DC DIFF BAL	
R107C	323-481	1 meg	½ w		Prec	1%	
R107E	321-189	909 Ω	⅛ w		Prec	1%	
R107F	311-441	200 Ω		Var		CH 1 X1000 ATTEN DC DIFF BAL	
R110	311-438	10 k		Var		CH 1 (+) GRID CURRENT ZERO	
R111	315-104	100 k	¼ w			5%	
R112	315-101	100 Ω	¼ w			5%	
R113	323-481	1 meg	½ w		Prec	1%	
R114	322-298	12.4 k	¼ w		Prec	1%	
R117	315-0103-00	10 k	¼ w			5%	X1130-up
R118	323-378	84.5 k	½ w		Prec	1%	
R119	315-123	12 k	¼ w			5%	
R124	322-344	37.4 k	¼ w		Prec	1%	
R125	323-298	12.4 k	½ w		Prec	1%	
R127	322-289	10 k	¼ w		Prec	1%	
R128	316-105	1 meg	¼ w				X550-up
R129	322-336	30.9 k	¼ w		Prec	1%	
R130	322-481	1 meg	¼ w		Prec	1%	
R131	311-082	2 meg	.1 w	Var		CH 1 DIFF BAL	
R133	319-035	5 meg	¼ w		Prec	2%	
R134	322-385	100 k	¼ w		Prec	1%	
R143	301-473	47 k	½ w			5%	
R144	315-102	1 k	¼ w			5%	
R150A	321-162	475 Ω	⅛ w		Prec	1%	100-1129
R150A	321-0708-00	485 Ω	⅛ w		Prec	1%	1130-up
R150B	321-192	976 Ω	⅛ w		Prec	1%	100-1129
R150B	321-0709-00	988 Ω	⅛ w		Prec	1%	1130-up
R150C	321-231	2.49 k	⅛ w		Prec	1%	100-1129
R150C	321-0710-00	2.542 k	⅛ w		Prec	1%	1130-up
R150D	321-262	5.23 k	⅛ w		Prec	1%	
R154	322-298	12.4 k	¼ w		Prec	1%	
R157	323-385	100 k	½ w		Prec	1%	
R159	Use 311-086	2.5 k		Var		CH 1 VAR DC BAL	
R163	301-243	24 k	½ w			5%	
R173	322-310	16.5 k	¼ w		Prec	1%	
R175	311-086	2.5 k		Var		CH 1 GAIN	
R181	315-333	33 k	¼ w			5%	
R183	315-473	47 k	¼ w			5%	
R185†	311-437	50 k		Var		CH 1 POSITION	
R187	303-753	75 k	1 w			5%	
R201	315-105	1 meg	¼ w			5%	
R202	315-101	100 Ω	¼ w			5%	
R205C	323-611	900 k	½ w		Prec	1%	
R205F	321-617	111 k	⅛ w		Prec	1%	
R206C	323-614	990 k	½ w		Prec	1%	
R206F	321-614	10.1 k	⅛ w		Prec	1%	
R207C	323-481	1 meg	½ w		Prec	1%	
R207F	321-193	1 k	⅛ w		Prec	1%	

† R185 and R235 furnished as a unit.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R210	311-438	10 k		Var	CH 1 (—) GRID CURRENT ZERO	
R211	315-104	100 k	¼ w		5%	
R212	315-101	100 Ω	¼ w		5%	
R213	323-481	1 meg	½ w	Prec	1%	
R214	322-298	12.4 k	¼ w	Prec	1%	
R230	322-481	1 meg	¼ w	Prec	1%	
R233	319-035	5 meg	¼ w	Prec	1%	
R234	322-385	100 k	¼ w	Prec	1%	
R235†	311-437	100 k		Var	CH 1 ATTEN BAL	
R239	321-280	8.06 k	⅛ w	Prec	1%	
R243	301-473	47 k	½ w		5%	
R250A	321-162	475 Ω	⅛ w	Prec	1%	100-1129
R250A	321-0708-00	485 Ω	⅛ w	Prec	1%	1130-up
R250B	321-192	976 Ω	⅛ w	Prec	1%	100-1129
R250B	321-0709-00	988 Ω	⅛ w	Prec	1%	1130-up
R250C	321-231	2.49 k	⅛ w	Prec	1%	100-1129
R250C	321-0710-00	2.542 k	⅛ w	Prec	1%	1130-up
R250D	321-262	5.23 k	⅛ w	Prec	1%	
R251J	323-322	22.1 k	½ w	Prec	1%	
R251L	323-368	66.5 k	½ w	Prec	1%	100-1129
R251L	323-0713-00	65.2 k	½ w	Prec	1%	1130-up
R251M	323-413	196 k	½ w	Prec	1%	100-1129
R251M	323-0714-00	192.2 k	½ w	Prec	1%	1130-up
R254	322-298	12.4 k	¼ w	Prec	1%	
R255	323-298	12.4 k	½ w	Prec	1%	
R257	323-385	100 k	½ w	Prec	1%	
R263	301-243	24 k	½ w		5%	
R264	301-123	12 k	½ w		5%	
R273	322-310	16.5 k	¼ w	Prec	1%	
R275	311-435	7 k		Var	CH 1 VARIABLE	
R277	322-193	1 k	¼ w	Prec	1%	
R281	315-333	33 k	¼ w		5%	
R283	315-473	47 k	¼ w		5%	
R301	315-105	1 meg	¼ w		5%	
R302	315-101	100 Ω	¼ w		5%	
R305C	323-611	900 k	½ w	Prec	1%	
R305E	Use 321-640	106 k	⅛ w	Prec	1%	
R305F	311-438	10 k		Var	CH 2 X10 ATTEN DC DIFF BAL	
R306C	323-614	990 k	½ w	Prec	1%	
R306E	Use 321-639	9.6 k	⅛ w	Prec	1%	
R306F	Use 311-393	1 k		Var	CH 2 X100 ATTEN DC DIFF BAL	
R307C	323-481	1 meg	½ w	Prec	1%	
R307E	321-189	909 Ω	⅛ w	Prec	1%	
R307F	311-441	200 Ω		Var	CH 2 X1000 ATTEN DC DIFF BAL	
R310	311-438	10 k		Var	CH 2 (+) GRID CURRENT ZERO	

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Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R311	315-104	100 k	1/4 w			5%	
R312	315-101	100 Ω	1/4 w			5%	
R313	323-481	1 meg	1/2 w		Prec	1%	
R314	322-298	12.4 k	1/4 w		Prec	1%	
R318	323-378	84.5 k	1/2 w		Prec	1%	
R319	315-123	12 k	1/4 w			5%	
R324	322-344	37.4 k	1/4 w		Prec	1%	
R325	323-298	12.4 k	1/2 w		Prec	1%	
R327	322-289	10 k	1/4 w		Prec	1%	
R329	322-336	30.9 k	1/4 w		Prec	1%	
R330	322-481	1 meg	1/4 w		Prec	1%	
R331	311-082	2 meg		Var		CH 2 DIFF BAL	
R333	319-035	5 meg	1/4 w		Prec	1%	
R334	322-385	100 k	1/4 w		Prec	1%	
R343	301-473	47 k	1/2 w			5%	
R344	315-102	1 k	1/4 w			5%	
R350A	321-162	475 Ω	1/8 w		Prec	1%	100-1129
R350A	321-0708-00	485 Ω	1/8 w		Prec	1%	1130-up
R350B	321-192	976 Ω	1/8 w		Prec	1%	100-1129
R350B	321-0709-00	988 Ω	1/8 w		Prec	1%	1130-up
R350C	321-231	2.49 k	1/8 w		Prec	1%	100-1129
R350C	321-0710-00	2.542 k	1/8 w		Prec	1%	1130-up
R350D	321-262	5.23 k	1/8 w		Prec	1%	
R354	322-298	12.4 k	1/4 w		Prec	1%	
R357	323-385	100 k	1/2 w		Prec	1%	
R359	Use 311-086	2.5 k		Var		CH 2 VAR DC BAL	
R363	301-243	24 k	1/2 w			5%	
R373	322-310	16.5 k	1/4 w		Prec	1%	
R375	311-086	2.5 k		Var		CH 2 GAIN	
R381	315-333	33 k	1/4 w			5%	
R383	315-473	47 k	1/4 w			5%	
R385†	311-437	50 k		Var		CH 2 POSITION	
R387	303-753	75 k	1 w			5%	
R401	315-105	1 meg	1/4 w			5%	
R402	315-101	100 Ω	1/4 w			5%	
R405C	323-611	900 k	1/2 w		Prec	1%	
R405E	321-617	111 k	1/8 w		Prec	1%	
R406C	323-614	990 k	1/2 w		Prec	1%	
R406E	321-614	10.1 k	1/8 w		Prec	1%	
R407C	323-481	1 meg	1/2 w		Prec	1%	
R407E	321-193	1 k	1/8 w		Prec	1%	
R410	311-438	10 k		Var	CH 2 (—) GRID	CURRENT ZERO	
R411	315-104	100 k	1/4 w			5%	
R412	315-101	100 Ω	1/4 w			5%	
R413	323-481	1 meg	1/2 w		Prec	1%	

† R385 and R435 furnished as a unit.

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Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R414	322-298	12.4 k	1/4 w		Prec	1%	
R430	322-481	1 meg	1/4 w		Prec	1%	
R433	319-035	5 meg	1/4 w		Prec	1%	
R434	322-385	100 k	1/4 w		Prec	1%	
R435†	311-437	100 k		Var		CH 2 ATTEN BAL	
R439	321-280	8.06 k	1/8 w		Prec	1%	
R443	301-473	47 k	1/2 w			5%	
R450A	321-162	475 Ω	1/8 w		Prec	1%	100-1129
R450A	321-0708-00	485 Ω	1/8 w		Prec	1%	1130-up
R450B	321-192	976 Ω	1/8 w		Prec	1%	100-1129
R450B	321-0709-00	988 Ω	1/8 w		Prec	1%	1130-up
R450C	321-231	2.49 k	1/8 w		Prec	1%	100-1129
R450C	321-0710-00	2.542 k	1/8 w		Prec	1%	1130-up
R450D	321-262	5.23 k	1/8 w		Prec	1%	
R451J	323-322	22.1 k	1/2 w		Prec	1%	
R451L	323-368	66.5 k	1/2 w		Prec	1%	100-1129
R451L	323-0713-00	65.2 k	1/2 w		Prec	1%	1130-up
R451M	323-413	196 k	1/2 w		Prec	1%	100-1129
R451M	323-0714-00	192.2 k	1/2 w		Prec	1%	1130-up
R454	322-298	12.4 k	1/4 w		Prec	1%	
R455	323-298	12.4 k	1/2 w		Prec	1%	
R457	323-385	100 k	1/2 w		Prec	1%	
R462	315-101	100 Ω	1/4 w			5%	
R463	301-243	24 k	1/2 w			5%	
R464	301-123	12 k	1/2 w			5%	
R473	322-310	16.5 k	1/4 w		Prec	1%	
R475	311-435	7 k		Var		CH 2 VARIABLE	
R477	322-193	1 k	1/4 w		Prec	1%	
R481	315-333	33 k	1/4 w			5%	
R483	315-473	47 k	1/4 w			5%	
R501	315-471	470 Ω	1/4 w			5%	100-1129
R501	315-0241-00	240 Ω	1/4 w			5%	1130-up
R502	322-322	22.1 k	1/4 w		Prec	1%	
R504	322-298	12.4 k	1/4 w		Prec	1%	
R509	322-610	500 k	1/4 w		Prec	1%	
R511	311-086	2.5 k	1/2 w	Var		CH 1 TRIG DC BAL	
R512	322-322	22.1 k	1/4 w		Prec	1%	
R514	322-298	12.4 k	1/4 w		Prec	1%	
R515	321-269	6.19 k	1/8 w		Prec	1%	
R519	322-610	500 k	1/4 w		Prec	1%	
R523	322-620	800 k	1/4 w		Prec	1%	
R525	311-110	100 k		Var		CH 1 TRIG DC LEVEL	
R527	322-620	800 k	1/4 w		Prec	1%	
R531	315-471	470 Ω	1/4 w			5%	100-1129
R531	315-0241-00	240 Ω	1/4 w			5%	1130-up

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R532	322-322	22.1 k	1/4 w		Prec 1%	
R534	322-298	12.4 k	1/4 w		Prec 1%	
R539	322-610	500 k	1/4 w		Prec 1%	
R541	311-086	2.5 k	1/2 w	Var	CH 2 TRIG DC BAL	
R542	322-322	22.1 k	1/4 w		Prec 1%	
R544	322-298	12.4 k	1/4 w		Prec 1%	
R545	321-269	6.19 k	1/8 w		Prec 1%	
R549	322-610	500 k	1/4 w		Prec 1%	
R553	322-620	800 k	1/4 w		Prec 1%	
R555	311-110	100 k		Var	CH 2 TRIG DC LEVEL	
R557	322-620	800 k	1/4 w		Prec 1%	
R561	322-481	1 meg	1/4 w		Prec 1%	
R563	321-441	383 k	1/8 w		Prec 1%	
R565	311-110	100 k		Var	COMP TRIG DC LEVEL	
R567	321-441	383 k	1/8 w		Prec 1%	
R569	322-481	1 meg	1/4 w		Prec 1%	
R583	301-473	47 k	1/2 w		5%	
R586	301-473	47 k	1/2 w		5%	
R601	315-474	470 k	1/4 w		5%	
R603	315-473	47 k	1/4 w		5%	
R604	315-203	20 k	1/4 w		5%	
R605	322-654	920 Ω	1/4 w		Prec 1%	
R611	315-474	470 k	1/4 w		5%	
R613	315-473	47 k	1/4 w		5%	
R614	315-203	20 k	1/4 w		5%	
R615	322-654	920 Ω	1/4 w		Prec 1%	
R616	315-103	10 k	1/4 w		1%	
R612	308-291	2 k	3 w		WW 5%	
R622	315-473	47 k	1/4 w		5%	
R623	315-102	1 k	1/4 w		5%	
R630	315-391	390 Ω	1/4 w		5%	X157-up
R631	308-291	2 k	3 w		WW 5%	
R632	315-473	47 k	1/4 w		5%	
R633	315-102	1 k	1/4 w		5%	
R635	308-292	2.2 k	3 w		WW 5%	
R638	315-103	10 k	1/4 w		5%	
R642	323-296	11.8 k	1/2 w		Prec 1%	
R643	322-606	25.6 k	1/4 w		Prec 1%	
R648	322-604	5.03 k	1/4 w		Prec 1%	
R649	323-268	6.04 k	1/2 w		Prec 1%	
R652	323-296	11.8 k	1/2 w		Prec 1%	
R653	322-606	25.6 k	1/4 w		Prec 1%	
R658	322-604	5.03 k	1/4 w		1%	
R661	Use 321-0122-00	182 Ω	1/8 w		Prec 1%	
R662	308-293	4 k	3 w		WW 5%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R665	311-169	100 Ω		Var	CALIBRATE	
R671	Use 321-0122-00	182 Ω	1/8 w		Prec 1%	
R672	308-293	4 k	3 w		WW 5%	
R673	315-101	100 Ω	1/4 w		5%	
R674	308-294	8 k	3 w		WW 5%	
R678	315-101	100 Ω	1/4 w		5%	
R679	308-294	8 k	3 w		WW 5%	
R681	308-293	4 k	3 w		WW 5%	
R683	301-0101-00	100 Ω	1/2 w		5%	X1130-up
R684	301-182	1.8 k	1/2 w		5%	
R685	323-298	12.4 k	1/2 w		Prec 1%	
R686	323-316	19.1 k	1/2 w		Prec 1%	
R689	301-163	16 k	1/2 w		5%	
R691	308-231	220 Ω	3 w		WW 5%	
R692	311-444	5 Ω		Var	CH 1 RANGE	
R694	311-444	5 Ω		Var	CH 2 RANGE	
R695	308-290	8 Ω	5 w		WW 5%	
R697	315-101	100 Ω	1/4 w		5%	
R699	315-223	22 k	1/4 w		5%	

Switches

	Unwired	Wired		
SW101	260-600		Lever	CH 1 (+) AC GND DC
SW105	260-590	*262-623	Rotary	CH 1 VOLTS/DIV 100-1129
SW105	260-0590-00	Use *050-0276-00	Rotary	CH 1 VOLTS/DIV 1130-1209
SW105	260-0590-00	*262-0623-02	Rotary	CH 1 VOLTS/DIV 1210-up
SW151	260-407		Toggle	CH 1 AC STAB
SW201	260-600		Lever	CH 1 (—) AC GND DC
SW261	260-552		Reed	
SW301	260-600		Lever	CH 2 (+) AC GND DC
SW305	260-590	*262-627	Rotary	CH 2 VOLTS/DIV 100-1129
SW305	260-590	Use *050-0277-00	Rotary	CH 2 VOLTS/DIV 1130-1209
SW305	260-0590-00	*262-0627-02	Rotary	CH 2 VOLTS/DIV 1210-up
SW351	260-407		Toggle	CH 2 AC STAB
SW401	260-600		Lever	CH 2 (—) AC GND DC
SW461	260-552		Reed	
SW462	260-407		Toggle	BANDWIDTH
SW570, SW620	Use 260-589	*262-624	Rotary	TRIGGER, MODE

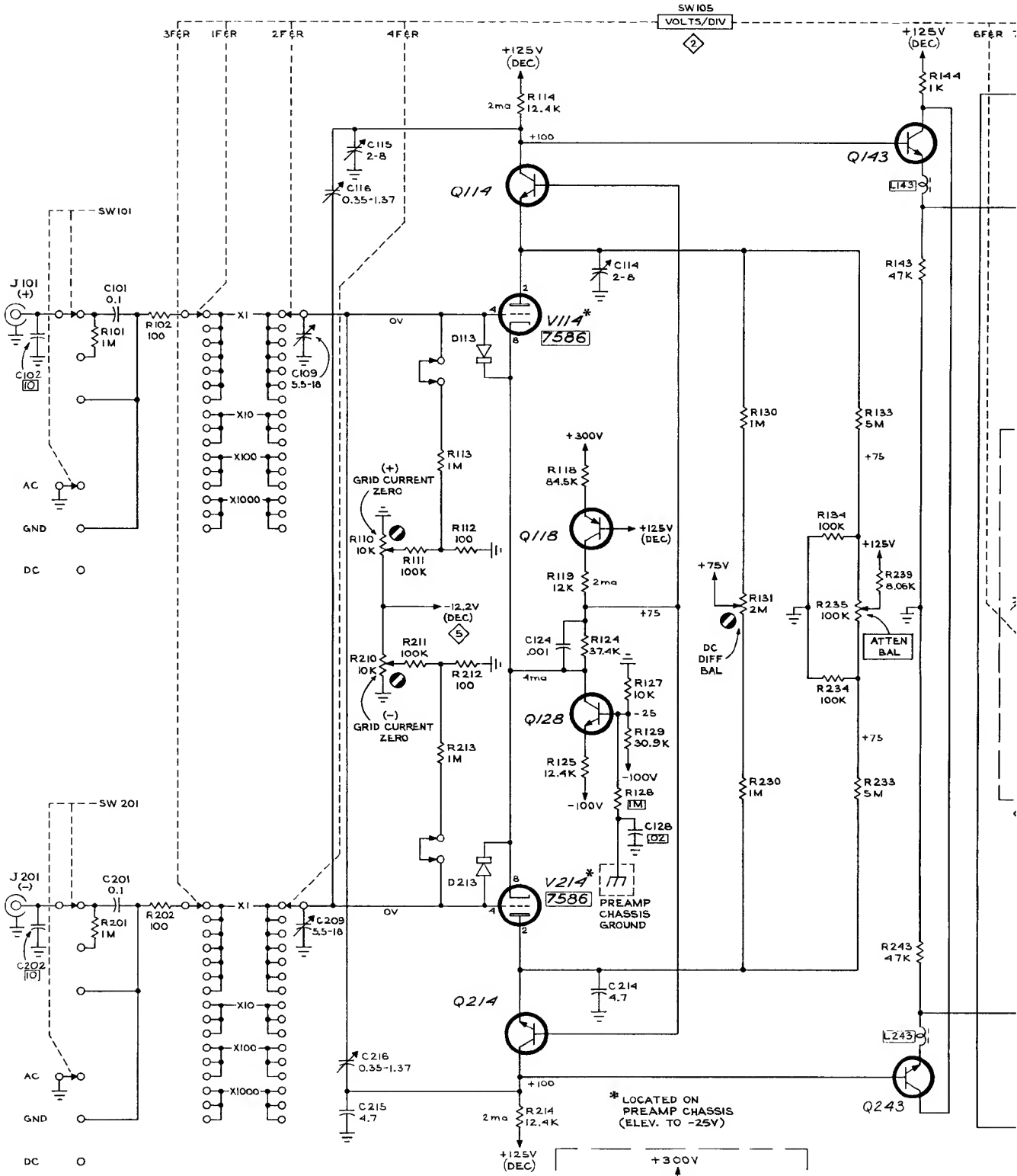
Transformer

T621	*120-334	Toroid, 7T Bifilar

Electron Tubes

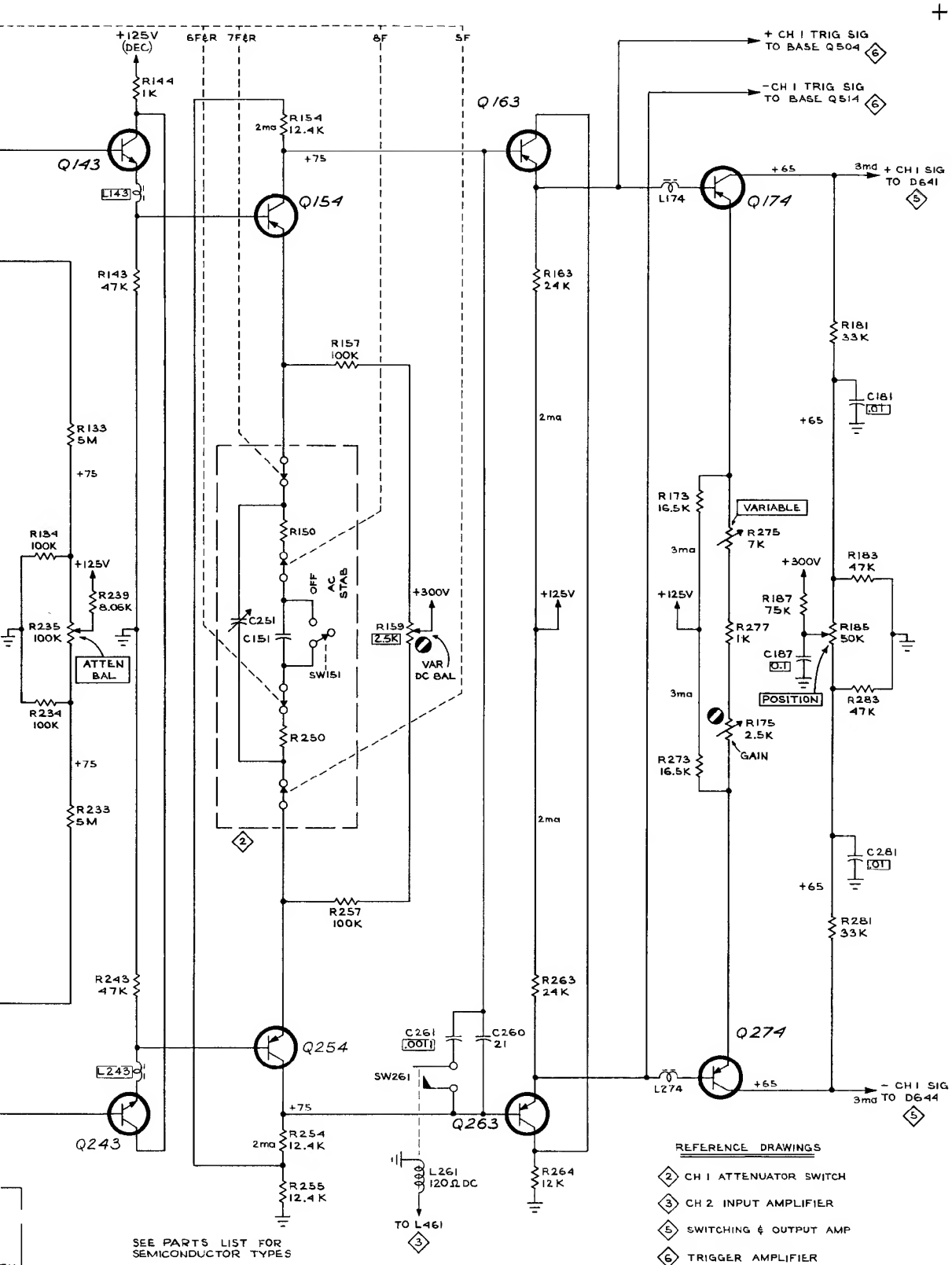
V114, V214	Use *157-0110-00	7586 Checked (1 pair)
V314, V414	Use *157-0110-00	7586 Checked (1 pair)
V583	154-187	6DJ8
V674	154-340	7119

©ī



TYPE 3A3 PLUG-IN

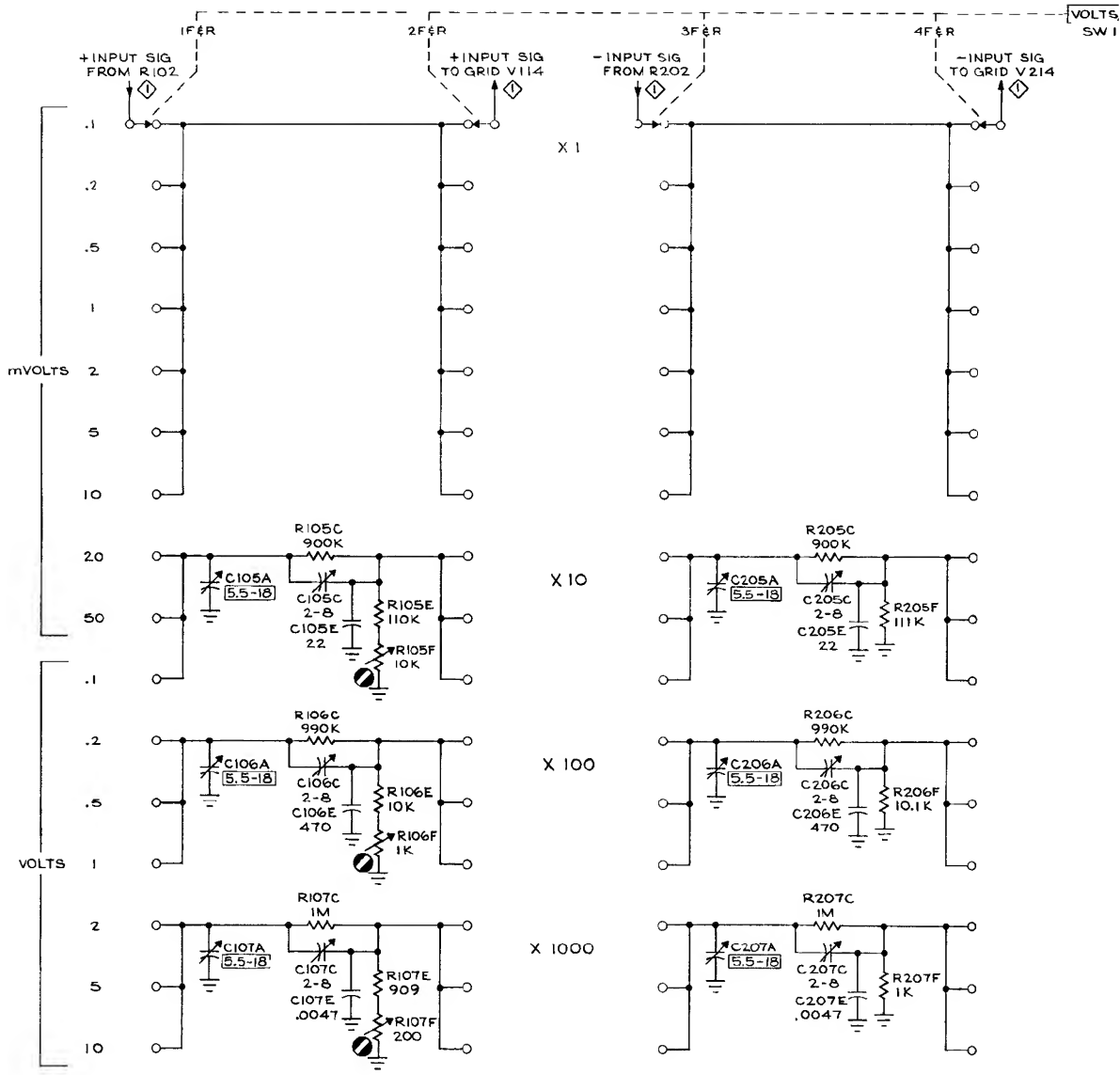
G



G

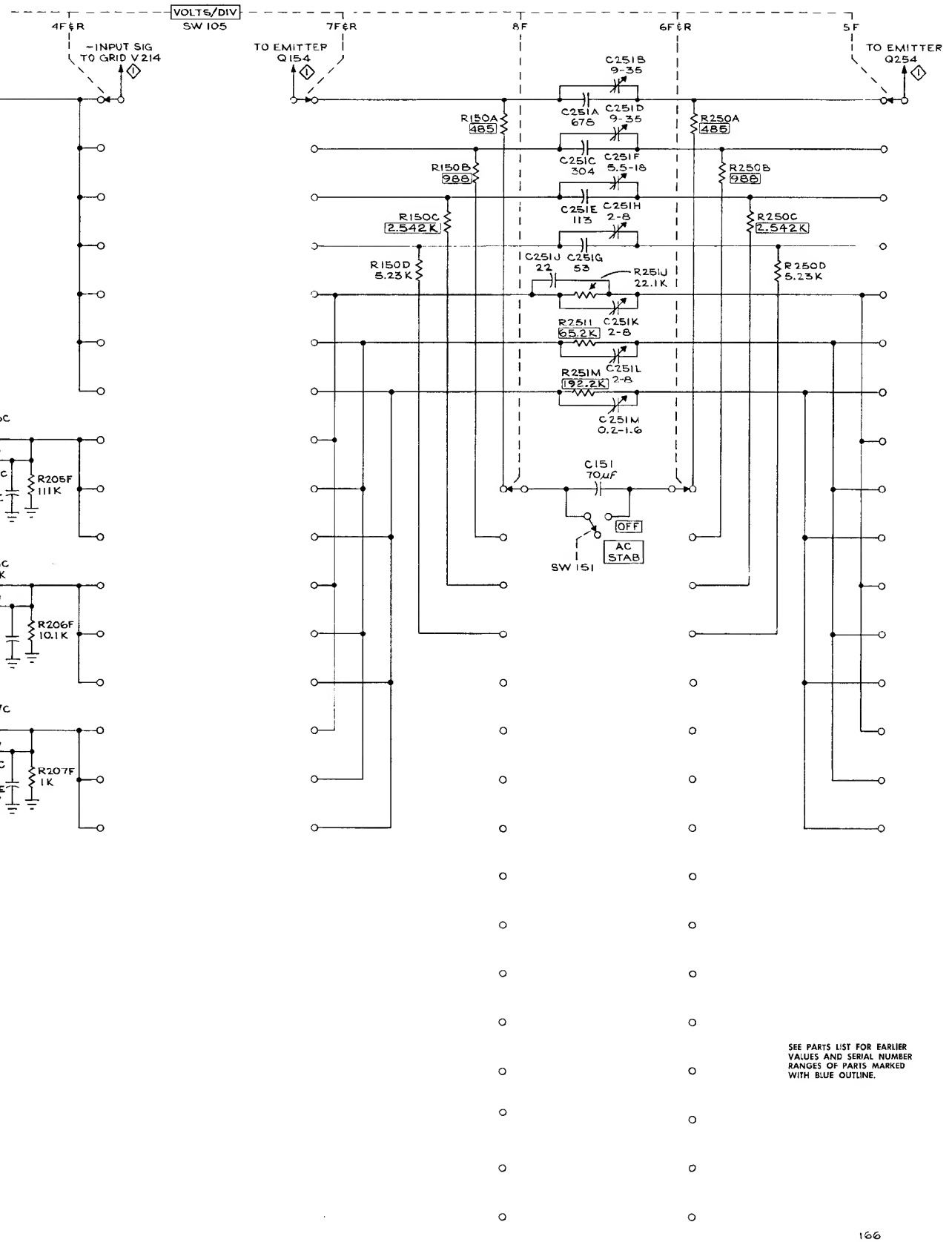
CH 1 INPUT AMPLIFIER 1

CMD 1265



REFERENCE DRAWINGS

① CH 1 INPUT AMPLIFIER

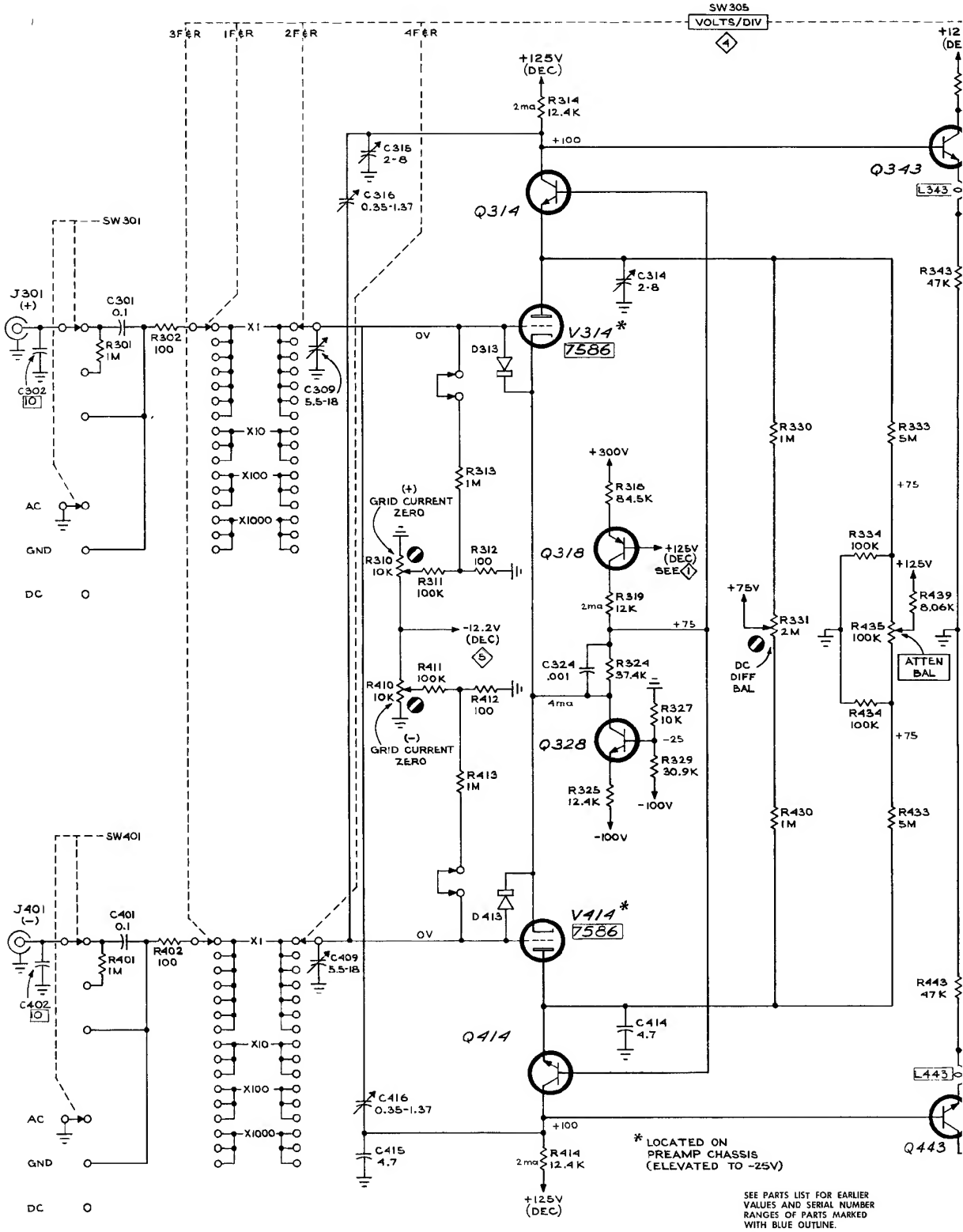


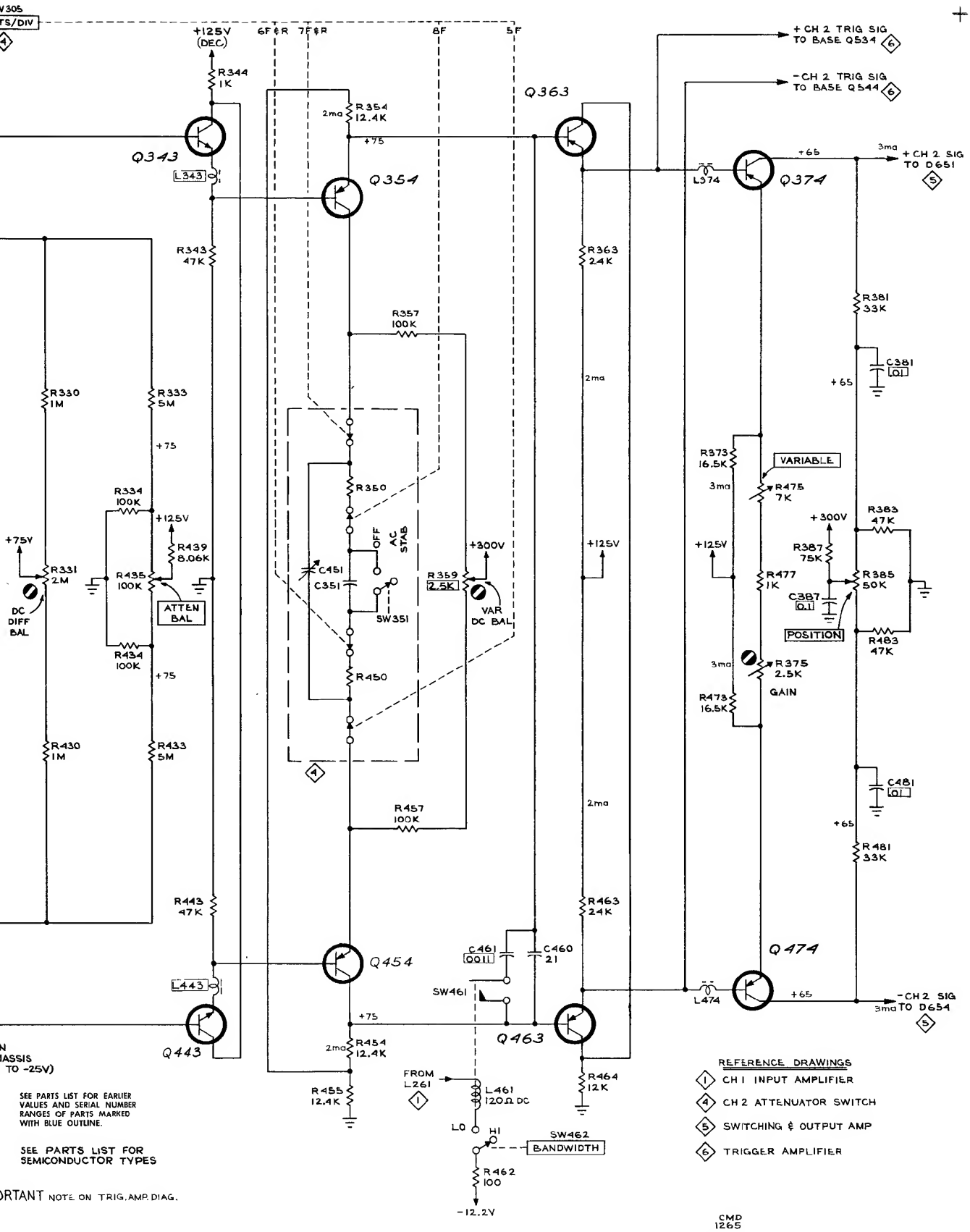
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

C

CH 1 ATTENUATOR SWITCH ◇2

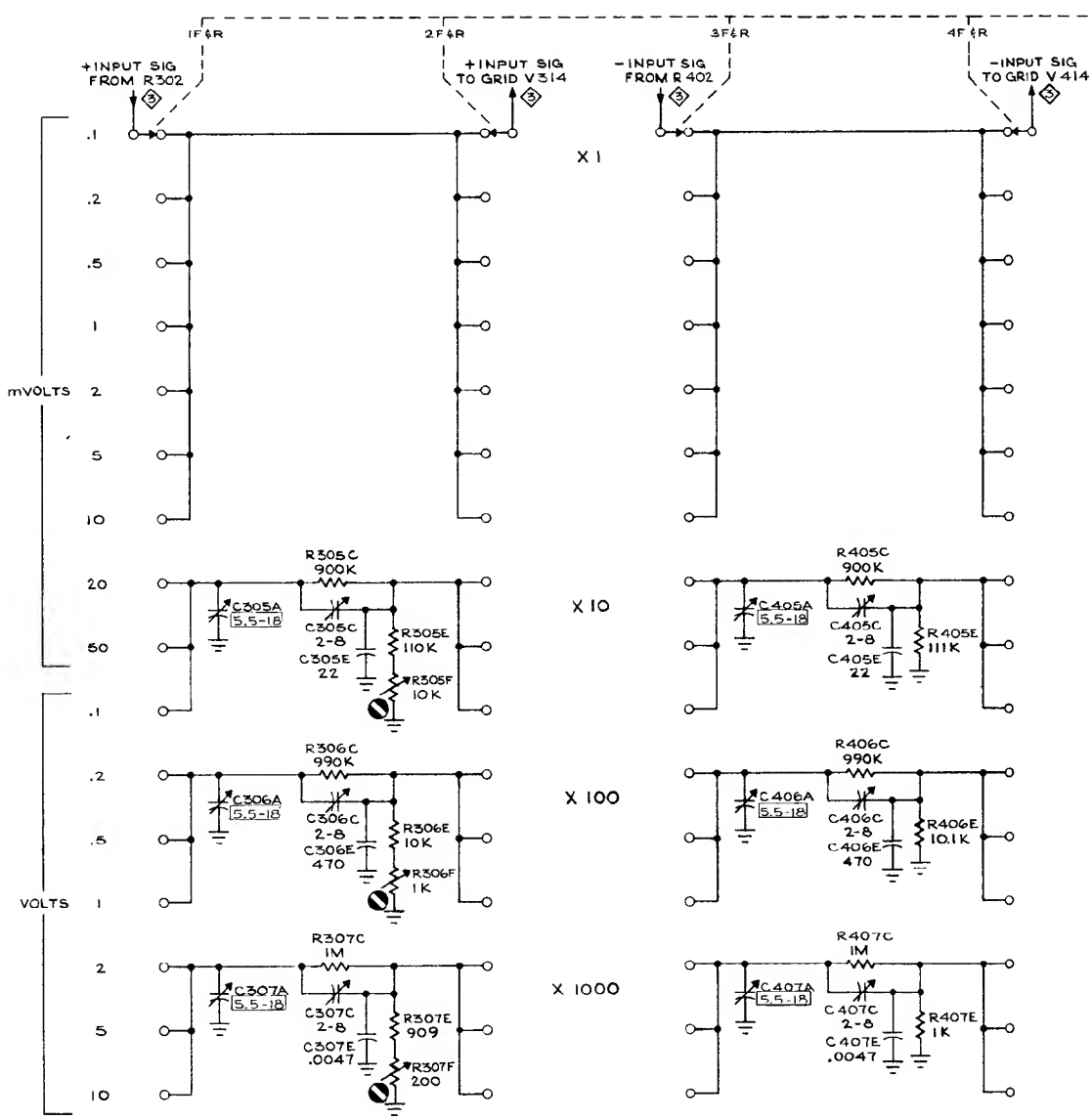
166
DON


SW305
VOLTS/DIV
4
3FER
1FER
2FER
4FER
+125V (DEC.)
R314 12.4K
2ma
+100
C315 2-8
C316 0.35-1.37
Q314
Q343
L343
C314 2-8
R343 47K
SW301
J301 (+)
C301 0.1
R301 1M
R302 100
X1
X10
X100
X1000
C302 10
C309 5.5-18
V314* 7586
0V
D313
R313 1M
(+) GRID CURRENT ZERO
R310 10K
R311 100K
R312 100
+300V
R316 84.5K
Q318
+125V (DEC) SEE 1
R319 12.2K
2ma
+75
-12.2V (DEC)
5
R411 100K
R410 10K
R412 100
(-) GRID CURRENT ZERO
C324 .001
R324 37.4K
4ma
R327 10K
-25
R329 30.9K
Q328
R325 12.4K
-100V
R413 1M
R330 1M
R333 5M
R334 100K
+125V
R439 8.06K
R435 100K
ATTEN BAL
R434 100K
+75V
R331 2M
DC DIFF BAL
R430 1M
R433 5M
SW401
J401 (-)
C401 0.1
R401 1M
R402 100
C402 10
C409 5.5-18
V414* 7586
D413
Q414
C414 4.7
R443 47K
L443
C416 0.35-1.37
C415 4.7
R414 12.4K
Q443
AC
GND
DC
* LOCATED ON PREAMP CHASSIS (ELEVATED TO -25V)
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
SEE IMPORTANT NOTE ON TRIG. AMP. DIAG.



CMD 1265

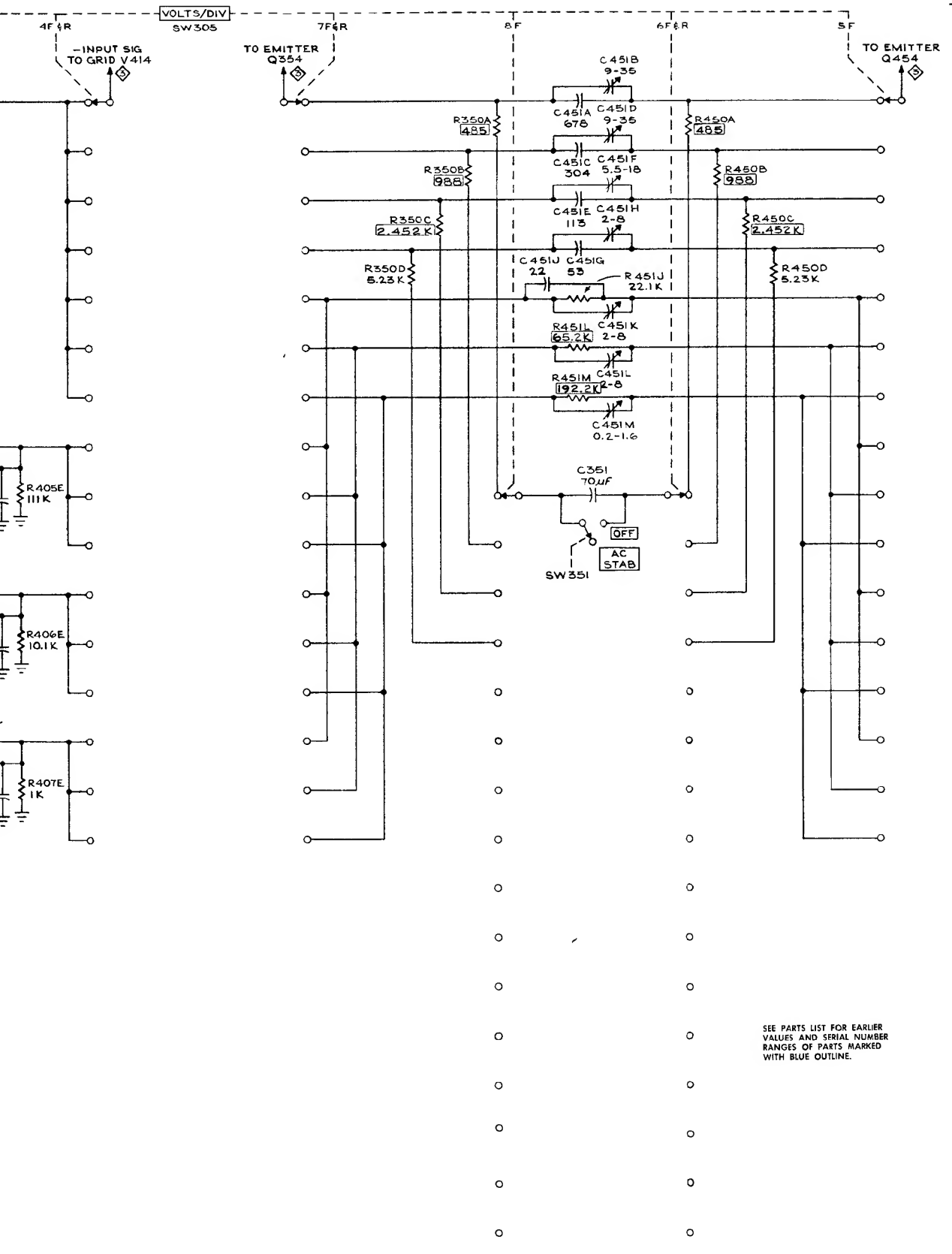
CH 2 INPUT AMPLIFIER 3



REFERENCE DRAWINGS

3 CH 2 INPUT AMPLIFIER

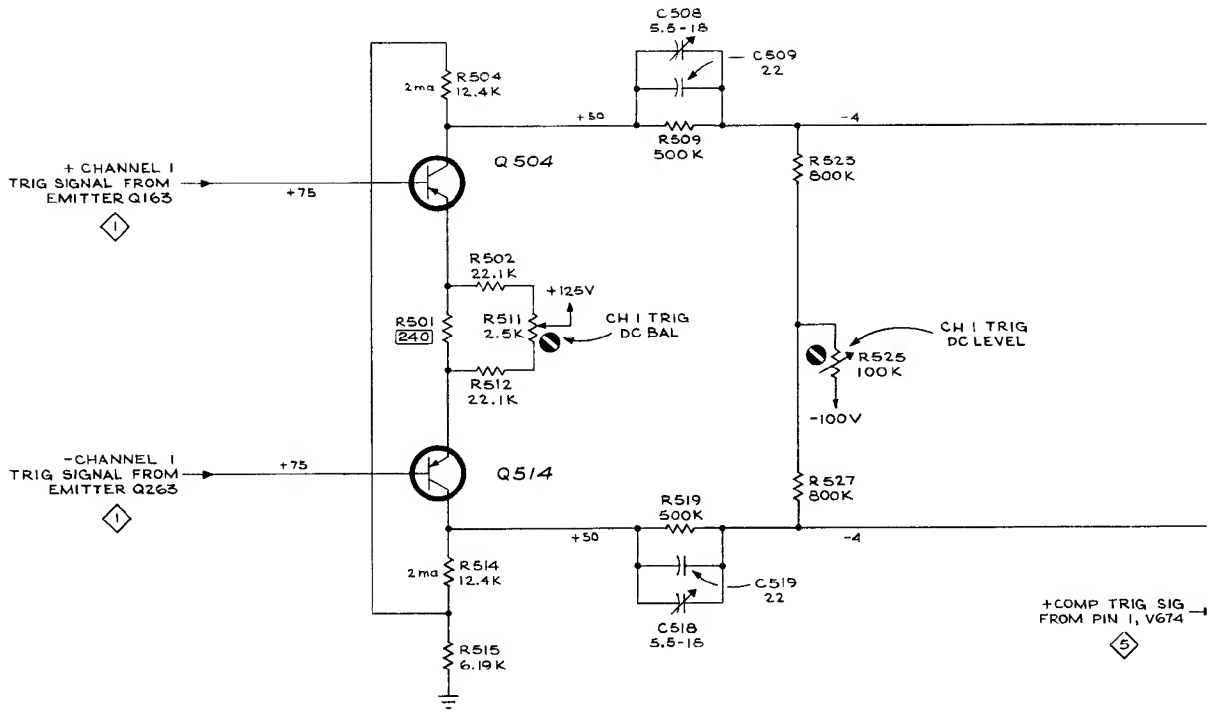
TYPE 3A3 PLUG-IN

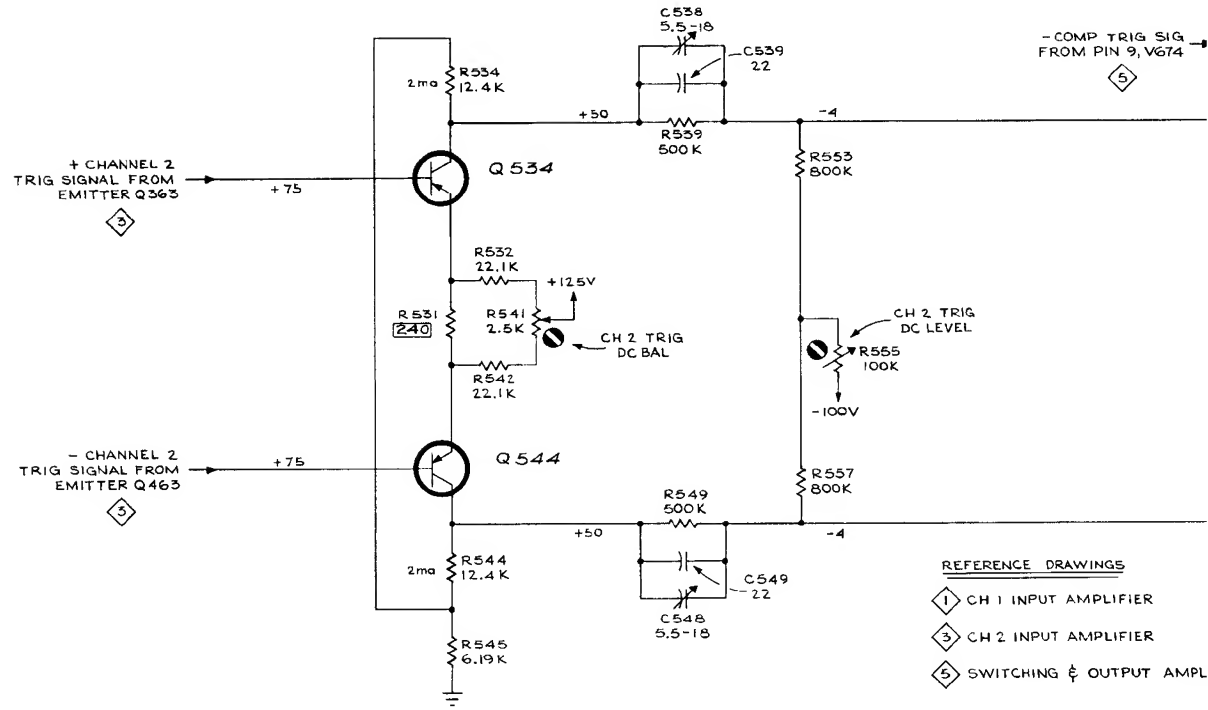


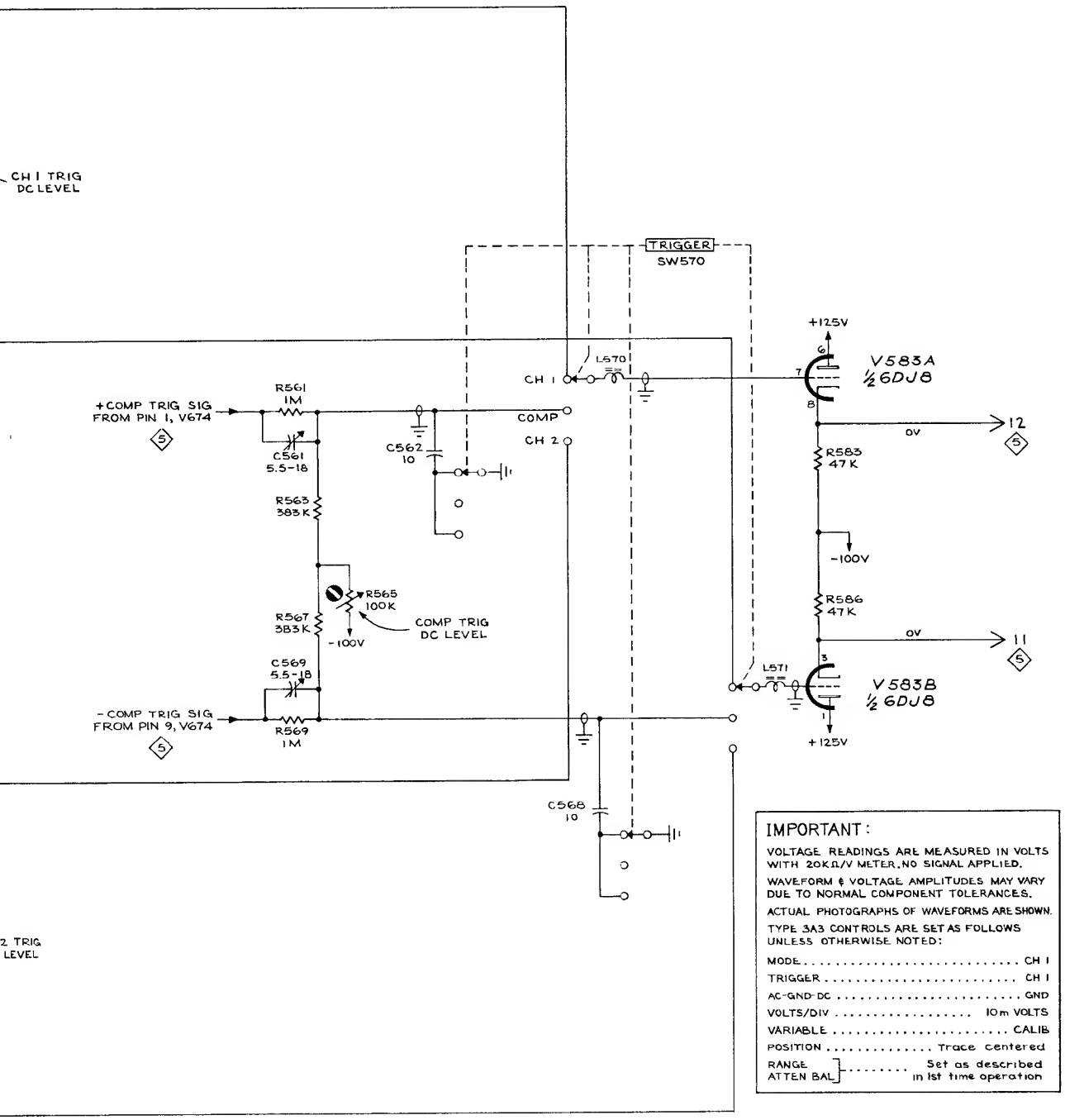
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

CH 2 ATTENUATOR SWITCH ◇4

DON
166


C508
5.5-18
C509
22
R504
12.4K
2ma
+50
-4
R509
500K
+ CHANNEL 1
TRIG SIGNAL FROM
EMITTER Q163
1
+75
Q504
R523
800K
R502
22.1K
+125V
R501
240
R511
2.5K
CH 1 TRIG
DC BAL
CH 1 TRIG
DC LEVEL
R525
100K
R512
22.1K
-100V
-CHANNEL 1
TRIG SIGNAL FROM
EMITTER Q263
1
+75
Q514
R527
800K
R519
500K
+50
-4
2ma
R514
12.4K
C519
22
C518
5.5-18
R515
6.19K
+COMP TRIG SIG
FROM PIN 1, V674
5


C538
5.5-18
C539
22
-COMP TRIG SIG
FROM PIN 9, V674
5
R534
12.4K
2ma
+50
-4
R539
500K
+ CHANNEL 2
TRIG SIGNAL FROM
EMITTER Q363
3
+75
Q534
R553
800K
R532
22.1K
+125V
R531
240
R541
2.5K
CH 2 TRIG
DC BAL
CH 2 TRIG
DC LEVEL
R555
100K
R542
22.1K
-100V
- CHANNEL 2
TRIG SIGNAL FROM
EMITTER Q463
3
+75
Q544
R557
800K
R549
500K
+50
-4
2ma
R544
12.4K
C549
22
C548
5.5-18
R545
6.19K
REFERENCE DRAWINGS
1 CH 1 INPUT AMPLIFIER
3 CH 2 INPUT AMPLIFIER
5 SWITCHING & OUTPUT AMPL



IMPORTANT:

VOLTAGE READINGS ARE MEASURED IN VOLTS WITH 20KΩ/V METER, NO SIGNAL APPLIED.

WAVEFORM & VOLTAGE AMPLITUDES MAY VARY DUE TO NORMAL COMPONENT TOLERANCES.

ACTUAL PHOTOGRAPHS OF WAVEFORMS ARE SHOWN.

TYPE 3A3 CONTROLS ARE SET AS FOLLOWS UNLESS OTHERWISE NOTED:

MODE	CH 1
TRIGGER	CH 1
AC-GND-DC	GND
VOLTS/DIV	10m VOLTS
VARIABLE	CALIB
POSITION	Trace centered
RANGE, ATTEN BAL	Set as described in 1st time operation

REFERENCE DRAWINGS

1 CH 1 INPUT AMPLIFIER

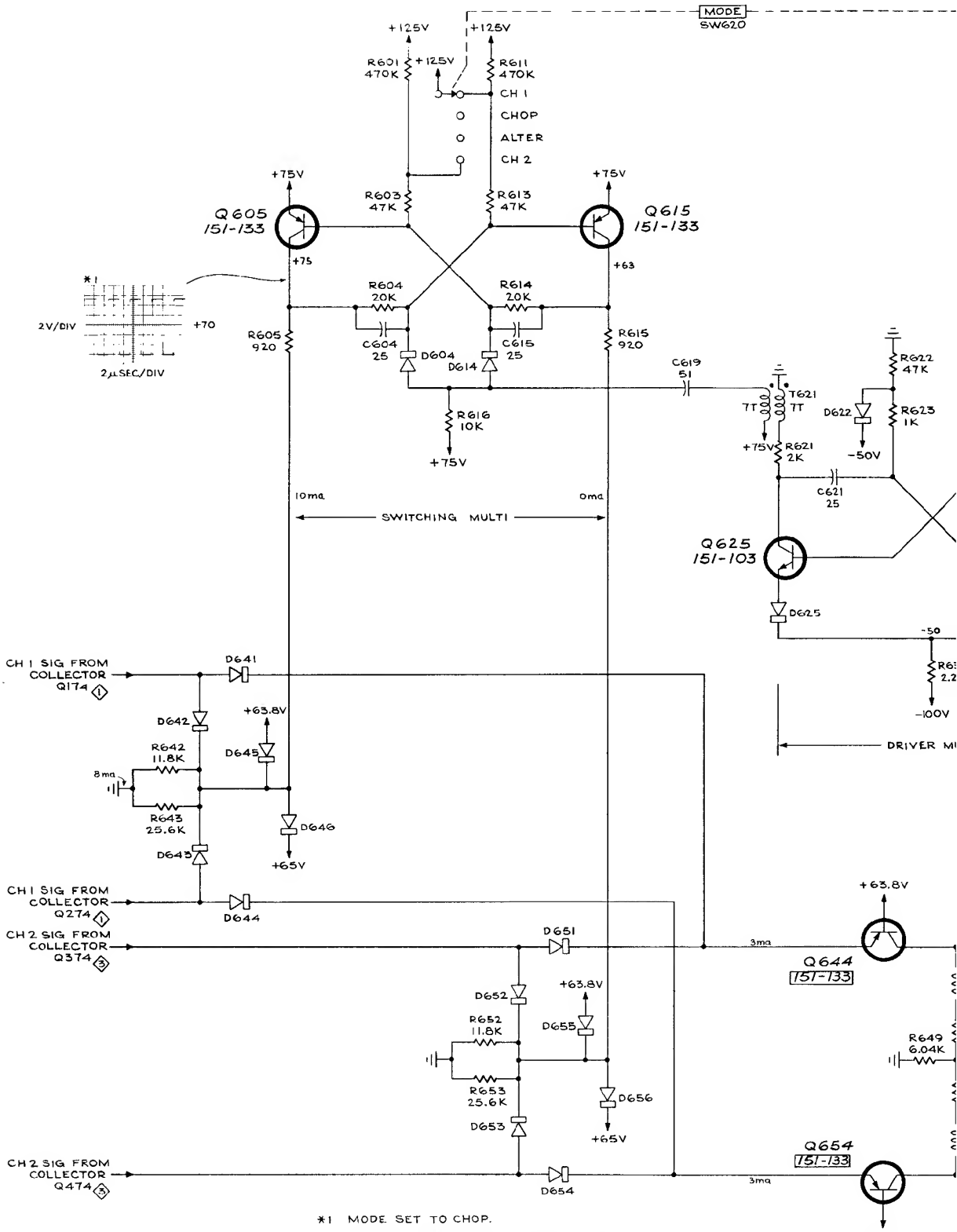
3 CH 2 INPUT AMPLIFIER

5 SWITCHING & OUTPUT AMPLIFIER

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

C

TRIGGER AMPLIFIER 6 DON 1265



*1 MODE SET TO CHOP.

*2 CHOPPED WAVEFORM FOR DUAL X-Y OPERATION, TWO TYPE 3A3 PLUG-INS WITH 2ND SET TO ALTER.

*3 NEGATIVE-GOING GATE PULSE FROM TYPE 2B67. TYPE 3A3 MODE SET TO ALTER.

SEE IMPORTANT NOTE ON TRIG. AMP. DIAG.

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

REFERENCE DRAWINGS

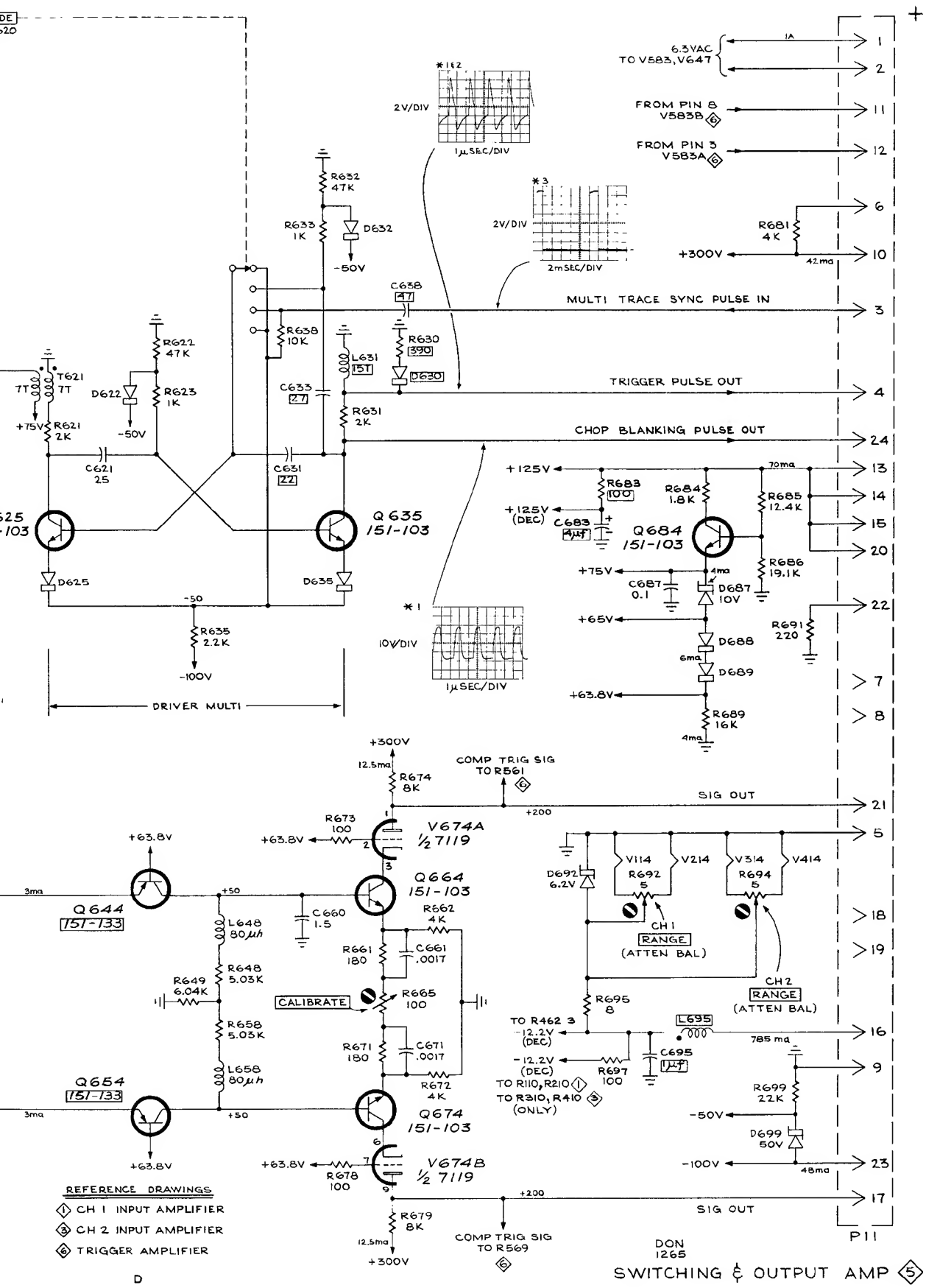
1 CH 1 INPUT AMPLIFIER

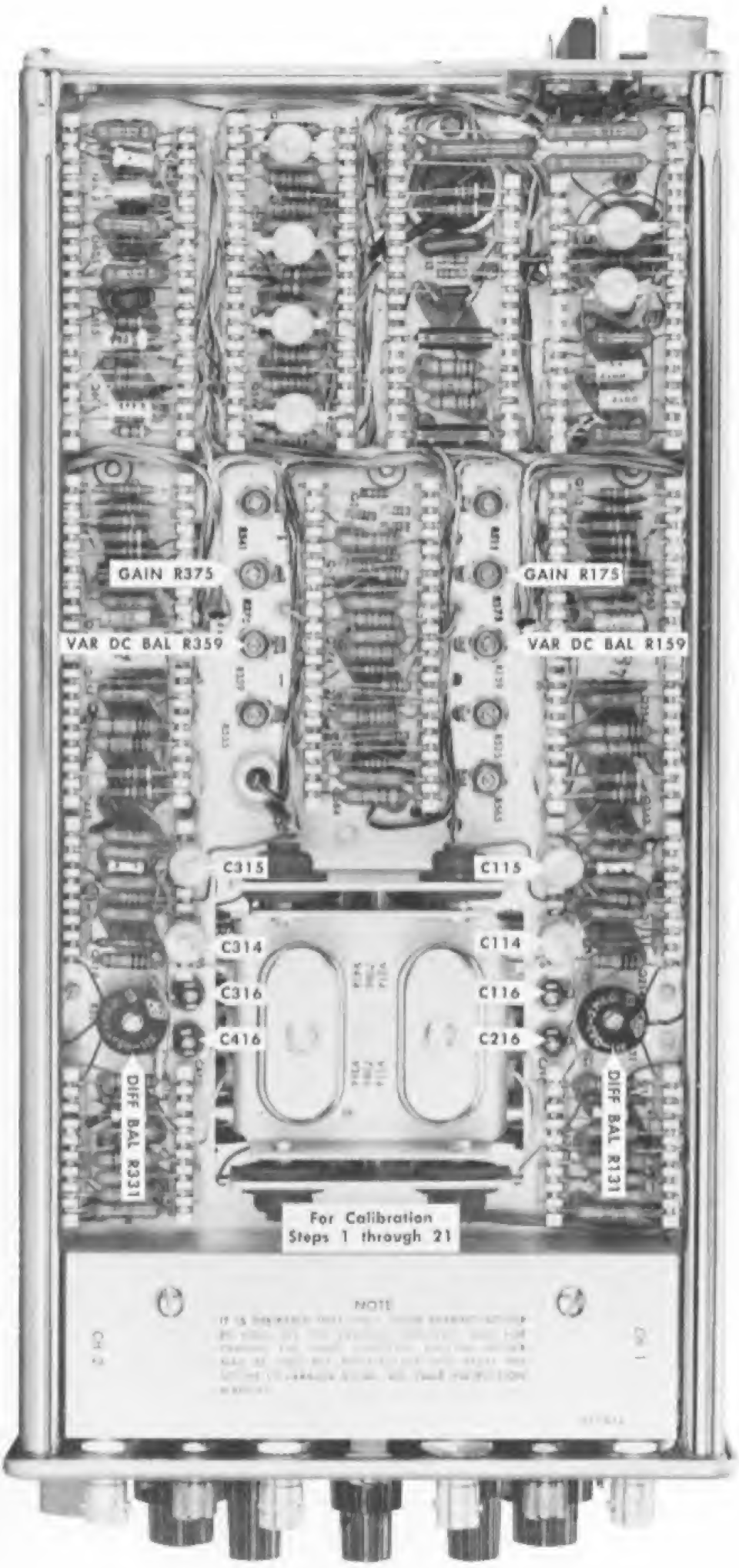
3 CH 2 INPUT AMPLIFIER

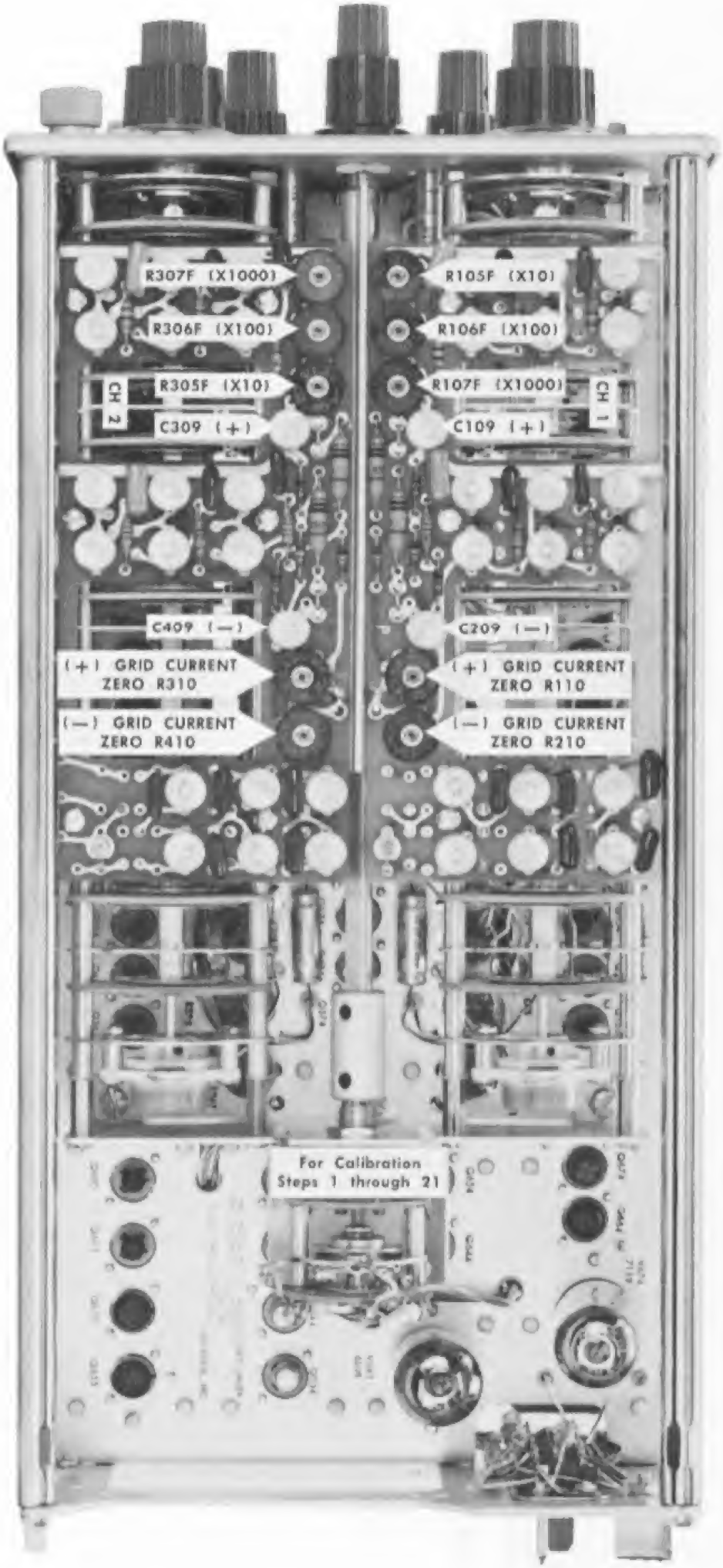
6 TRIGGER AMPLIFIER

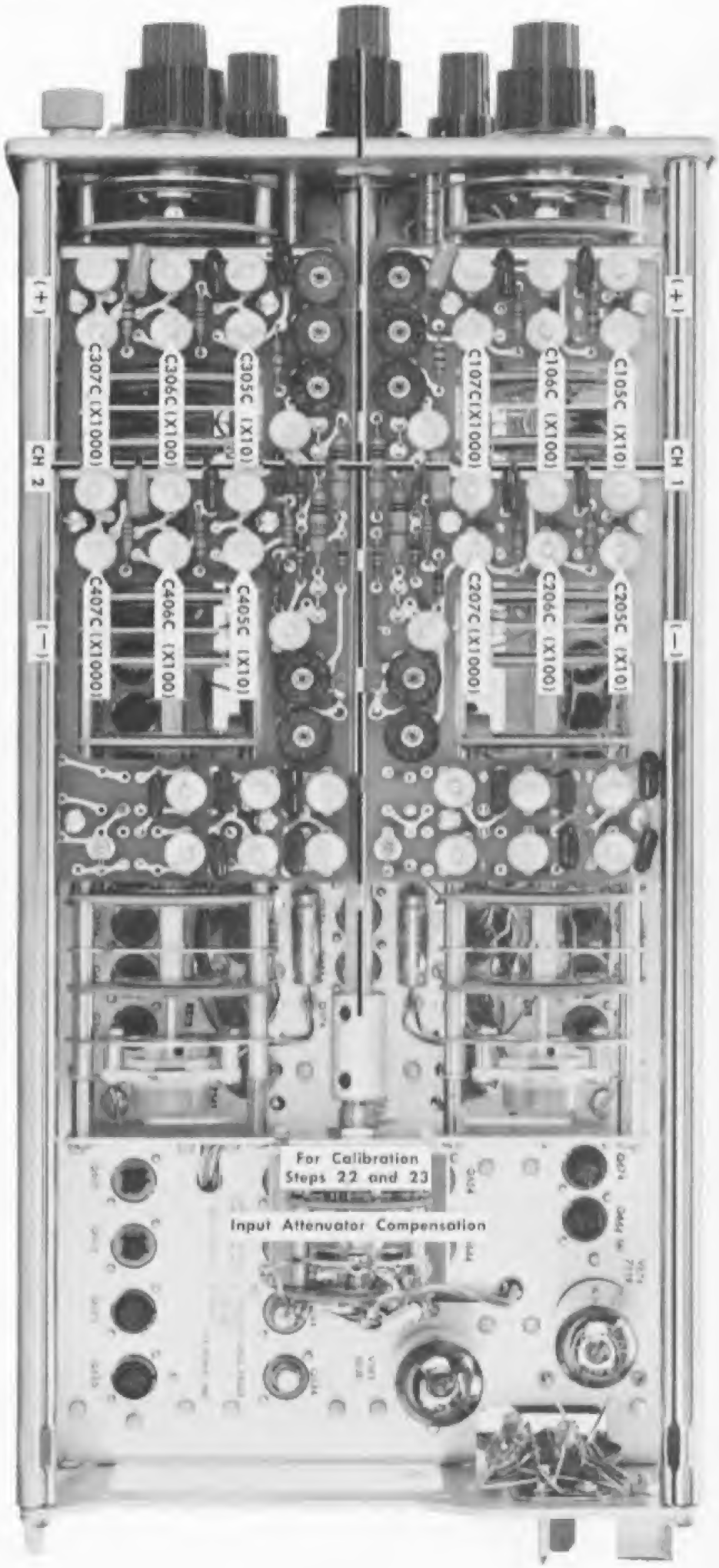
TYPE 3A3 PLUG-IN

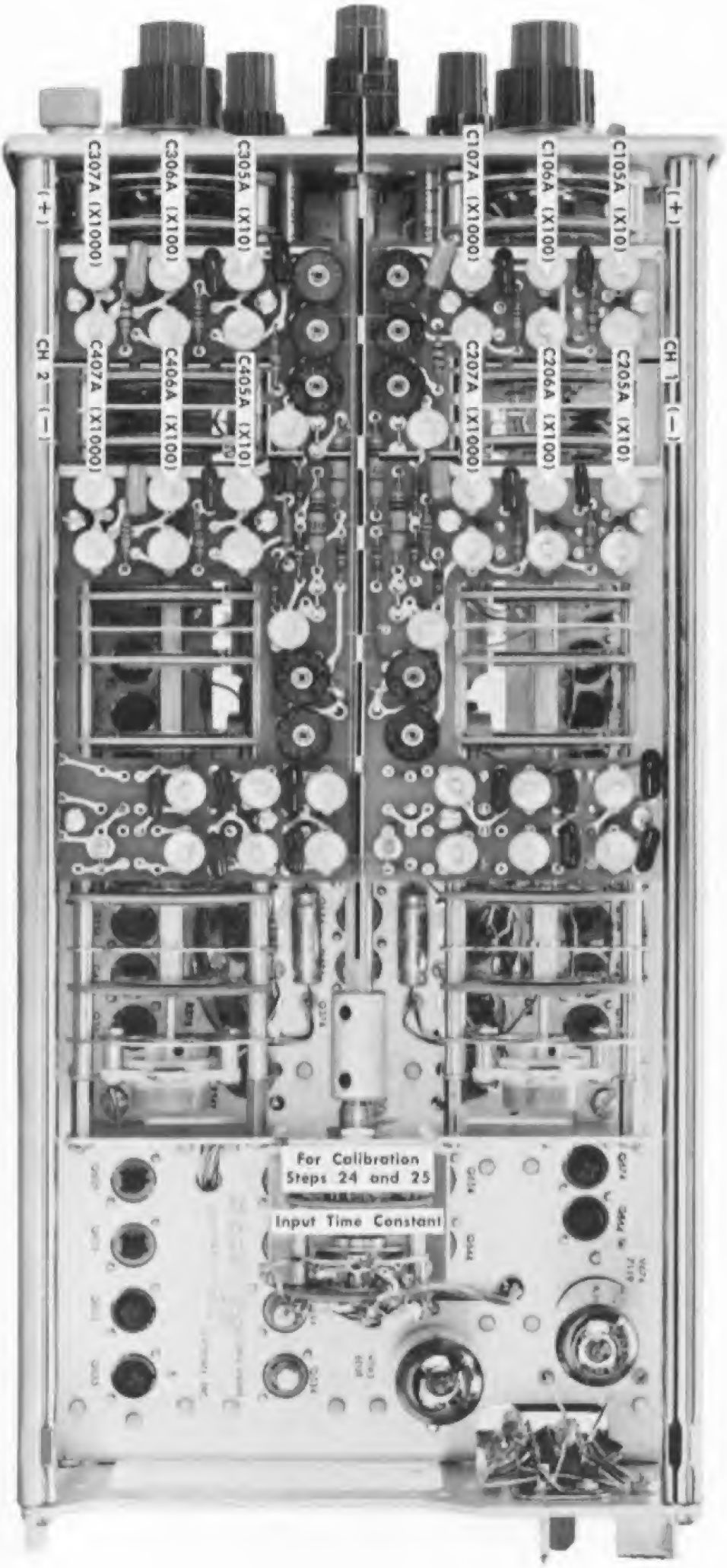
D

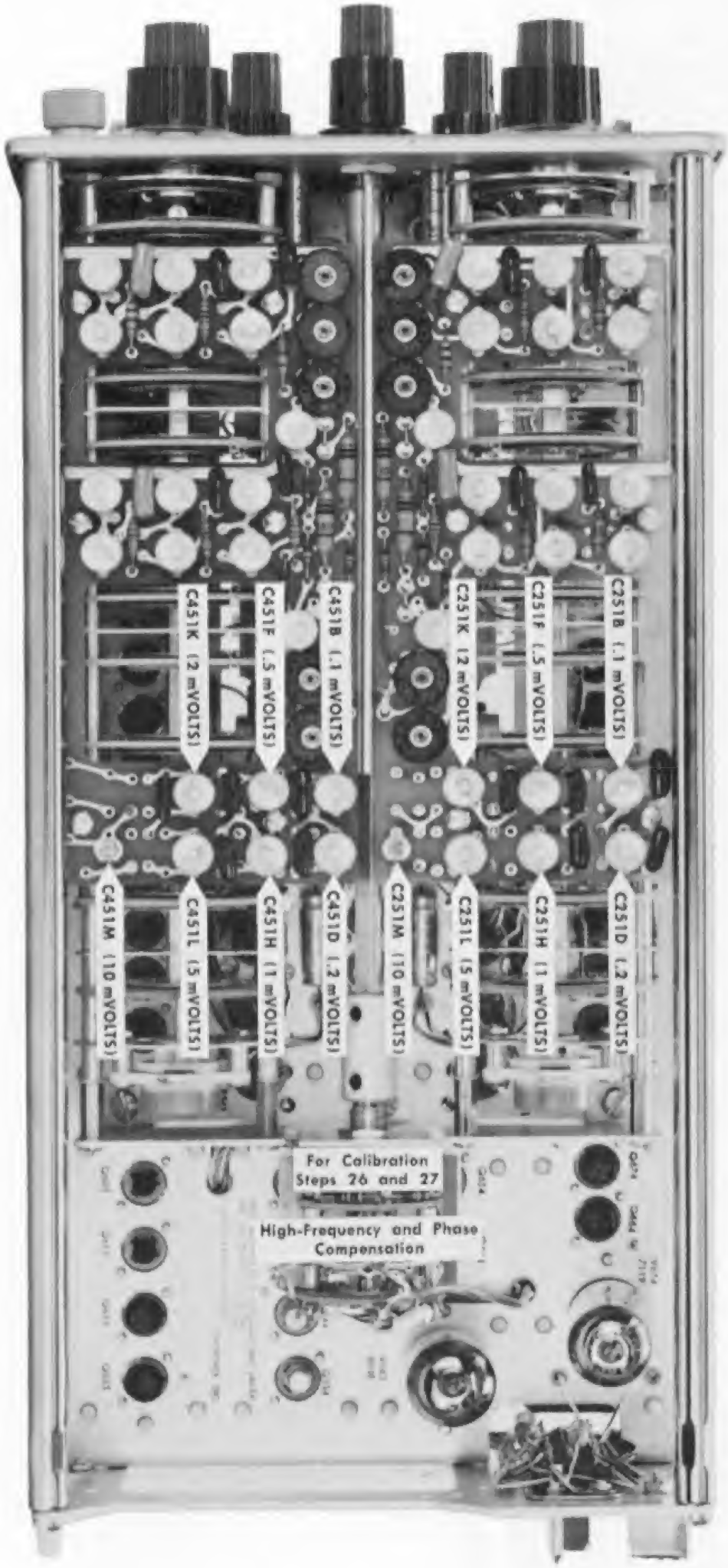

6.3VAC TO V583, V647
1A
FROM PIN 8 V583B
FROM PIN 3 V583A
+300V
42ma
MULTI TRACE SYNC PULSE IN
TRIGGER PULSE OUT
CHOP BLANKING PULSE OUT
+125V
70ma
+125V (DEC)
+75V
4ma
+65V
6ma
+63.8V
4ma
-50V
-100V
DRIVER MULTI
2V/DIV
1μSEC/DIV
2mSEC/DIV
10V/DIV
Q635 151-103
Q684 151-103
Q644 151-133
Q664 151-103
Q654 151-133
Q674 151-103
V674A ½ 7119
V674B ½ 7119
+300V
12.5ma
COMP TRIG SIG TO R561
SIG OUT
+200
CH 1 RANGE (ATTEN BAL)
CH 2 RANGE (ATTEN BAL)
CALIBRATE
TO R462 3
-12.2V (DEC)
TO R110, R210 1
TO R310, R410 3 (ONLY)
785 ma
COMP TRIG SIG TO R569
P11
DON 1265
SWITCHING & OUTPUT AMP 5
REFERENCE DRAWINGS
1 CH 1 INPUT AMPLIFIER
3 CH 2 INPUT AMPLIFIER
6 TRIGGER AMPLIFIER
D

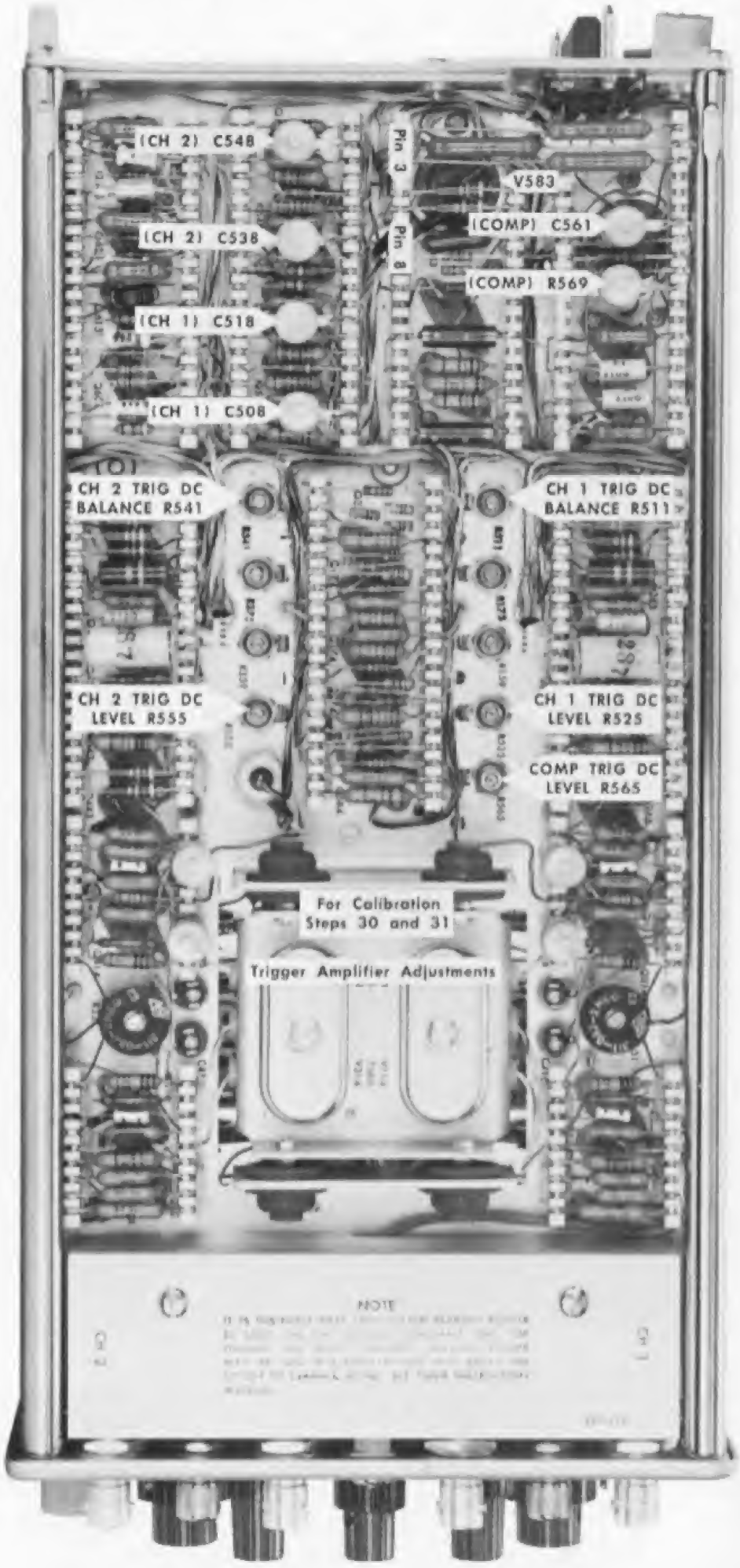

GAIN R375
GAIN R175
VAR DC BAL R359
VAR DC BAL R159
C315
C115
C314
C114
C316
C116
C416
C216
DIFF BAL R331
DIFF BAL R131
For Calibration
Steps 1 through 21
NOTE


R307F (X1000)
R306F (X100)
R305F (X10)
C309 (+)
CH 2
R105F (X10)
R106F (X100)
R107F (X1000)
C109 (+)
CH 1
C409 (—)
C209 (—)
(+) GRID CURRENT ZERO R310
(—) GRID CURRENT ZERO R410
(+) GRID CURRENT ZERO R110
(—) GRID CURRENT ZERO R210
For Calibration Steps 1 through 21


(+)
CH 2
(−)
C307C (X1000)
C306C (X100)
C305C (X10)
C407C (X1000)
C406C (X100)
C405C (X10)
(+)
CH 1
(−)
C107C (X1000)
C106C (X100)
C105C (X10)
C207C (X1000)
C206C (X100)
C205C (X10)
For Calibration
Steps 22 and 23
Input Attenuator Compensation


C307A (X1000)
C306A (X100)
C305A (X10)
C107A (X1000)
C106A (X100)
C105A (X10)
(+)
CH 2 (−)
C407A (X1000)
C406A (X100)
C405A (X10)
C207A (X1000)
C206A (X100)
C205A (X10)
(+)
CH 1 (−)
For Calibration
Steps 24 and 25
Input Time Constant


C451K (2 mVOLTS)
C451F (.5 mVOLTS)
C451B (.1 mVOLTS)
C251K (2 mVOLTS)
C251F (.5 mVOLTS)
C251B (.1 mVOLTS)
C451M (10 mVOLTS)
C451L (5 mVOLTS)
C451H (1 mVOLTS)
C451D (.2 mVOLTS)
C251M (10 mVOLTS)
C251L (5 mVOLTS)
C251H (1 mVOLTS)
C251D (.2 mVOLTS)
For Calibration Steps 26 and 27
High-Frequency and Phase Compensation


(CH 2) C548
(CH 2) C538
(CH 1) C518
(CH 1) C508
Pin 3
Pin 8
V583
(COMP) C561
(COMP) R569
CH 2 TRIG DC BALANCE R541
CH 1 TRIG DC BALANCE R511
CH 2 TRIG DC LEVEL R555
CH 1 TRIG DC LEVEL R525
COMP TRIG DC LEVEL R565
For Calibration Steps 30 and 31
Trigger Amplifier Adjustments
NOTE

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE 3A3 TENT SN 1750

PARTS LIST CORRECTION

CHANGE TO:

C660	281-0529-00	1.5 pF (nominal value)

This is a test selected part and installed only if necessary.

TYPE 3A3 TENT SN 1820

PARTS LIST CORRECTION

CHANGE TO:

L143, L243, L343, L443, L570, L571	276-0507-00	Core, Shield Bead